Grain Quality and Biochemistry
Progress Report 16/90

Groundnut Quality

Report of Work

January 1987 - December 1989

ICRISAT

International Crops Research Institute for the Semi-Arid Tropics

Patancheru, Andhra Pradesh 502 324, India

Grain Quality and Biochemistry
Progress Report 16/90

GROUNDNUT QUALITY

Report of Work

January 1987 - December 1989

International Crops Research Institute for the Semi-Arid Tropics
Patancheru, Andhra Pradesh 502 324, India

LIST OF TABLES

CONTENTS

FOREWORD

Our earlier reports on groundnut dealt with the analyses of groundnut germplasm accessions for their oil and protein contents. In this document, we have reported the data obtained on other aspects of groundnut seed quality. We have described the procedures in somewhat more detail as the data are reported for the first time from our laboratory.

THIS IS NOT AN OFFICIAL PUBLICATION OF ICRISAT AND SHOULD NOT BE CITED.

R. Jambunathan
June 1990

GRAIN QUALITY AND BIOCHEMISTRY*

Dr. R. Jambunathan	-	Principal Biochemist and Program Leader
Mrs. Santosh Gurtu	-	Senior Research Associate I
Mr. N. Sambasiva Rao	-	Research Associate II
Mr. N. Subrahmanyam	-	Research Associate II**
Mrs. R. Seetha Kannan	-	Research Associate II
Mr. A. Lakshma Reddy	-	Research Associate II
Mr. K. Raghunath	-	Research Associate II
Mr. R. Sridhar	-	Research Associate I**
Dr. M. Saroja	-	Research Associate I
Mr. G. Soma Raju	-	Senior Laboratory Assistant
Mr. M. Chandra Sekhar	-	Senior Laboratory Attendant
Mr. T.S.N. Prashanth	-	Office Assistant
Mr. K.D.V. Prasad	-	Junior Office Assistant

COLLABORATORS

Legumes Program* (Groundnut Group)

Dr. S.N. Nigam
Principal Plant Breeder

Dr. S.L. Dwivedi, Plant Breeder

Dr. V.K. Mehan, Plant Pathologist

Resource Management Program*

Dr. K.L. Sahrawat
Senior Soil Scientist

Genetic Resources Unit*

Dr. V. Ramanatha Rao, Botanist

*Only the names of those who were directly associated with the work reported are included

**On leave

Groundnut Quality Progress Report 1987-1989

Project Number : G-113 (85) IC

Project Title : Evaluation of nutritional and food quality of groundnut

Objectives and scope

1. Determine the protein and oil content in groundnut
2. Determine the proximate composition of groundnut including vitamins, sugars, and protein quality
3. Determine the oil quality including the fatty acid composition in groundnut
4. Initiate and standardize taste panel evaluation studies.

SECTION I. CHEMICAL COMPOSITION

I. CHEMICAL COMPOSITION

1.0 INTRODUCTION

The utility potential of groundnut (Arachis hypogaea L.) has increased considerably as novel ways for its utilization are being investigated. Groundnut is a highly concentrated form of food, rich in protein, oil, and with reasonable amount of vitamins (Venkatrao and Jogi Pantulu 1958). Groundnut oil is an important edible vegetable oil and contains high concentrations of unsaturated essential fatty acids, oleic and linoleic acids. These have a bearing on the stability and nutritional quality of the oil.

Groundnut has relatively low ash and carbohydrate contents when compared to other major oil seeds, the major carbohydrates being starch and sugars. Groundnut contains as many as 26 mineral elements according to Cobb and Johnson (1973), potassium content being relatively high and sodium being low. Groundnut is nutritionally deficient in calcium and zinc, and is fairly good in phosphorus and magnesium contents (National Academy of Sciences, 1980).

2.0 MATERIALS AND METHODS

2.1 Materials

In our present investigation, we analyzed groundnut cultivars that were grown during the two seasons. Five groundnut cultivars, ICGS 1 (ICGV 87119), ICGS 5 (ICGV 87121), ICGS 11 (ICGV 87123), ICGS 21 (ICGV 87124), and ICGS 44 (ICGV 87128), were grown at ICRISAT Center during the 1985/86 postrainy season,

in the fields, RP 10A, RP 10A, RP 10B, RP 10B and RP 8C. Two controls, Kadiri 3 (Robut 33-1) and J 11, were also included for this study. The above mentioned groundnut cultivars were also grown during the 1988 rainy season in the fields of RP 11C, RP 11C, RP 11C, RP 11C, and RP 11B, RP 3B and RL 18 at ICRISAT Center, including the controls.

2.2 Methods

2.2.1 Determination of protein content

Nitrogen content was determined using the Technicon auto analyzer (TAA), according to Singh and Jambunathan, (1980). A factor of 5.46 was used for converting the nitrogen into crude protein content.

2.2.2 Determination of oil content

Soxhlet method : Oil was determined in groundnut meal by extracting with n-hexane in a Soxhlet apparatus and also using the nuclear magnetic resonance spectrometer (Jambunathan et al. 1985).

2.2.3 Determination of starch and sugar contents

Starch which consists of amylose and amylopectin, was analyzed according to the method of Thivend et al (1972) and sugars by the method of Dubois et al. (1956). Starch was hydrolyzed using amyloglucosidase enzyme (source : Sigma) which converts starch to maltose and then to glucose which was determined using the phenol-sulphuric acid reagent. Total soluble sugars in groundnut meal were determined by extracting

with hot aqueous-ethanol, and measuring the concentration of the golden yellow colored complex formed using the phenol sulfuric acid reagent at 490 nm.

2.2.4 Ash and crude fiber contents

Ash content was determined according to the method of Association of Analytical Chemists (AOAC), method (1984[a]). Groundnut sample, after defatting, was ignited to 600°C and the ash content determined.

Crude fiber, which is the organic fraction left after sequential extraction with solutions of 1.25% sulfuric acid and 1.25% sodium hydroxide, gives the cellulose content of the sample. The method followed was according to AOAC (1984[b])

2.2.5 Moisture content

Moisture content was determined by drying the groundnut meal at 110°C for 16 hr in a forced draft oven.

2.2.6 Determination of minerals and trace elements

The minerals and trace elements were analyzed according to the method of AOAC (1984[c]). The wet digestion method was followed for phosphorus content and the dry ashing method for the analysis of other elements. The wet digestion method involves the digestion of the ground sample with a mixture of acids (nitric acid, sulfuric acid, and perchloric acid), followed by analysis of phosphorus content in the digest using the Technicon auto analyzer.

Table 1. Chemical composition of groundnut cultivars, postrainy season 1985/86, ICRISAT Center[1]

Cultivar	Protein	Oil	Starch	Sugar	Fiber	Ash	Moisture	100 seed mass (g)
	(%)							
ICGS 1	24.9±0.09	48.3±0.30	11.8±0.06	4.6±0.10	2.2±0.05	2.3±0.01	7.3±0.08	56.2
ICGS 5	25.7±0.13	48.2±0.15	12.3±0.06	4.6±0.08	2.3±0.07	2.3±0.01	6.8±0.13	60.7
ICGS 11	25.0±0.46	48.3±0.15	11.8±0.09	4.6±0.08	2.2±0.03	2.3±0.02	6.7±0.01	57.3
ICGS 21	26.2±0.15	50.0±0.20	11.3±0.06	5.0±0.17	2.0±0.03	2.3±0.00	6.8±0.12	69.3
ICGS 44	25.4±0.52	49.1±0.12	12.2±0.13	4.4±0.03	2.1±0.05	2.2±0.02	7.1±0.22	63.1
Controls								
Kadiri 3	29.2±0.20	46.4±0.09	11.2±0.14	3.6±0.01	2.1±0.05	2.2±0.01	5.0±0.03	48.1
J 11	25.8±0.15	47.2±0.03	13.7±0.06	5.2±0.17	2.1±0.03	2.4±0.01	5.1±0.06	31.0
Mean[2]	25.8	48.2	12.0	4.6	2.2	2.3	6.4	55.1
SE[2]	±0.61	±0.44	±0.32	±0.19	±0.03	±0.02	±0.35	±4.71

1. Means of three replicates
2. Means & SE of seven cultivars

For other elements, the sample was ashed in the muffle furnace at 600°C, and the ash was dissolved in dilute hydrochloric acid, and few drops of nitric acid and the aliquot was analyzed in an atomic absorption spectrophotometer.

3.0 RESULTS AND DISCUSSION

3.1 Chemical Composition

Results of analysis of cultivars grown in the postrainy season 1985/86 are shown in Table 1. ICGS 21 showed the highest 100 seed mass (69.3 g), sugar content (5.0%) and oil content (50.0%), among the groundnut cultivars. J 11 showed the highest content of starch (13.7%), and ash (2.4%). ICGS 5 had a higher percentage of starch, and protein among the five ICRISAT cultivars.

The results of the 1988 rainy season presented in Table 2 reveal that the two cultivars, ICGS 21 and ICGS 5 were better than the controls in some respects. ICGS 21 had the highest oil content and 100 seed mass among the ICRISAT cultivars. The protein, sugar, fiber, and ash, contents were higher in ICGS 5 as compared to the controls. A comparison of the results from the two seasons' data showed that hundred seed mass and protein content were higher in the postrainy 1985/86 season, while starch and sugars were higher in the 1988 rainy season.

For nitrogen determination, we were using the nitrogen free paper for weighing ground, undefatted groundnut sample. The groundnut sample in the nitrogen free paper was folded carefully

Table 2. Chemical composition of groundnut cultivars, rainy season, 1988 ICRISAT Center[1]

Cultivars	Protein	Oil	Starch	Sugar	Fiber	Ash	Moisture	100 seed mass (g)
	(%)							
ICGS 1	20.7±0.12	50.0±0.12	14.4±0.16	5.9±0.10	2.3±0.06	2.5±0.01	4.6±0.06	37.0±0.52
ICGS 5	21.4±0.07	48.5±1.24	14.0±0.19	6.3±0.03	2.7±0.07	2.7±0.15	4.7±0.03	37.0±0.48
ICGS 11	21.4±0.15	48.7±0.10	13.8±0.18	5.9±0.06	2.6±0.09	2.5±0.02	4.7±0.09	37.2±0.39
ICGS 21	19.1±0.44	50.3±0.00	14.1±0.34	5.8±0.03	2.6±0.08	2.5±0.01	4.7±0.00	43.8±0.28
ICGS 44	20.5±0.12	50.0±0.11	13.6±0.12	6.0±0.00	2.3±0.04	2.5±0.04	4.6±0.09	36.4±0.20
Controls								
Kadiri 3	19.9±0.10	47.5±0.11	15.5±0.20	6.6±0.13	2.5±0.09	2.6±0.01	5.0±0.03	40.0±0.10
J 11	20.9±0.26	48.1±0.21	14.5±0.09	6.1±0.07	2.5±0.09	2.6±0.02	4.8±0.06	26.2±0.10
Mean[2]	20.6	49.0	14.2	6.1	2.5	2.6	4.7	36.8
SE[2]	±0.31	±0.43	±0.23	±0.11	±0.06	±0.03	±0.05	±2.01

1. Means of three replicates
2. Means and SE of seven cultivars

and then transferred into the digestion tube. This process was however, cumbersome and time consuming and delayed the weighing process considerably. Since we were analyzing thousands of samples every month, we looked into the possibility of using the butter paper, normally used with other ground grains. Our concern was that butter paper may absorb or retain some oil during the weighing process and may affect the nitrogen values. In order to compare the nitrogen values obtained using nitrogen free paper and butter paper, thirty-seven groundnut samples were analyzed, using butter paper as well as nitrogen free paper in the weighing operation. The correlation coefficient of data obtained by these two procedures was 0.96 (Table 3). Therefore the use of nitrogen free paper was discontinued in favor of butter paper, for increasing the analytical rate

3.2 Minerals and trace elements

All the seven groundnut cultivars mentioned earlier, grown during the 1985/86 postrainy and 1988 rainy season were analyzed for their P, K, Ca, Mg, Zn, Cu, Fe and Mn contents. The results of these analyses expressed as mg.(100 g)$^{-1}$ samples are shown in Tables 4 and 5. Recommended dietary allowances suggested by the National Academy of Sciences are given for comparison (Recommended Dietary Allowances, 1980).

There was variation in the potassium content, ranging from 631 to 700 mg (100 g)$^{-1}$ of sample. A similar variation was also observed for phosphorus and magnesium in the postrainy season 1985/86 cultivars (Table 4). There was not much variation in the

Table 3. A comparison of groundnut protein values obtained by using nitrogen free paper and butter paper

Sample No.	Protein (%)	
	Nitrogen free paper (A)	Butter paper (B)
1	21.8	21.8
2	23.3	23.0
3	25.9	25.8
4	24.3	24.3
5	26.2	26.1
6	26.6	26.9
7	25.2	25.8
8	26.6	26.2
9	21.2	21.0
10	25.2	25.1
11	26.9	26.2
12	25.5	25.4
13	21.4	21.2
14	25.6	25.8
15	24.1	24.6
16	26.4	26.3
17	26.0	25.5
18	26.1	25.6
19	26.1	26.2
20	25.5	25.1
21	21.4	20.8
22	26.4	25.7
23	20.0	21.0
24	25.0	24.3
25	25.5	24.3
26	23.9	23.0
27	24.2	23.6
28	23.1	24.7
29	26.1	26.0
30	23.8	22.4
31	29.5	28.8
32	26.4	26.9
33	23.6	24.0
34	26.6	26.1
35	24.8	24.8
36	27.6	26.7
37	27.8	27.9

Correlation coefficient between A and B was 0.96 ($P \leq 0.01$)

Table 4. Minerals and trace elements composition [mg(100 g)$^{-1}$] of groundnut cultivars, postrainy season 1985/86, ICRISAT Center[1]

Cultivar	Phosphorus	Potassium	Calcium	Magnesium	Zinc	Copper	Iron	
ICGS 1	405±3.3	700±1.7	95±8.8	212±6.1	2.9±0.07	0.8±0.01	5.9±0.06	1.1±0.01
ICGS 5	400±9.6	685±7.5	86±1.7	207±0.0	2.8±0.03	0.9±0.02	7.3±0.37	1.2±0.02
ICGS 11	405±1.7	660±6.7	93±2.9	204±1.7	2.9±0.08	0.8±0.01	5.3±0.07	1.2±0.02
ICGS 21	392±1.7	637±10.9	75±5.8	193±4.4	2.8±0.04	0.9±0.01	4.7±0.12	0.9±0.02
ICGS 44	390±4.4	631±0.0	92±2.9	191±2.7	2.7±0.02	0.8±0.00	6.0±0.40	1.1±0.02
Controls								
Kadiri 3	398±1.7	678±6.7	79±2.9	201±3.2	2.6±0.02	0.8±0.00	5.9±0.54	0.9±0.02
J 11	420±3.3	688±6.6	75±5.3	211±3.3	2.7±0.03	0.8±0.00	4.6±0.13	1.2±0.03
Mean[2]	401	668	85	203	2.8	0.8	5.7	1.1
SE[2]	±3.8	±10.0	±3.3	±3.1	±0.04	±0.01	±0.37	±0.05
dietary allowance[3]	800	-	800	350	15	2-3	10	2.5-5.0

1. Means of three replicates
2. Means and SE of seven cultivars
3. Recommended dietary allowance for an adult male, National Academy of Sciences, USA (1980)

Table 5. Minerals and trace elements composition (mg(100 g)$^{-1}$) of groundnut cultivars, rainy season 1988, ICRISAT Center[1]

Cultivar	Phosphorus	Potassium	Calcium	Magnesium	Zinc	Copper	Iron	
ICGS 1	345±0.0	512±14.5	62±1.7	197±6.0	3.2±0.06	0.8±0.01	4.3±0.04	1.1±0.01
ICGS 5	352±2.9	530±26.7	53±4.4	211±10.0	3.0±0.04	0.8±0.01	4.7±0.77	1.2±0.02
ICGS 11	357±6.7	525±14.0	74±1.7	202±4.4	3.1±0.05	0.8±0.02	3.8±0.33	1.1±0.03
ICGS 21	366±6.0	516±3.3	52±1.7	201±1.7	3.2±0.04	0.8±0.02	4.4±0.05	1.3±0.01
ICGS 44	345±10.0	513±16.4	63±4.4	195±5.8	2.9±0.05	0.7±0.00	5.1±0.42	1.3±0.07
Controls								
Kadiri 3	550±15.0	600±30.9	58±9.2	189±5.0	3.5±0.03	0.9±0.01	4.1±0.03	1.3±0.02
J 11	370±11.3	538±4.7	67±3.2	206±2.0	3.2±0.02	0.8±0.01	3.6±0.01	1.0±0.01
Mean[2]	381	533	61	200	3.1	0.8	4.3	1.2
SE[2]	±25.1	±17.9	±2.9	±6.4	±0.08	±0.02	±0.19	±0.04
Recommended dietary allowance[3]	800	-	800	350	15	2-3	10	25-50

1. Means of three replicates
2. Means and SE of seven cultivars
3. Recommended dietary allowance for an adult male, National Academy of Sciences, USA (1980)

contents of copper, zinc, and manganese. ICGS 1 showed the highest contents of potassium, calcium, and magnesium. ICGS 5 was comparatively high in iron. The concentrations of minerals in the 1988 rainy season, in general, were lower than the 1985/86 postrainy season.

References

AOAC 1984. Association of Analytical Chemists. Official methods of analysis. 14th ed. Pages 154[a], 160[b] and 161[c] in Association of Official Analytical Chemists (Williams S. ed.), Virginia, USA

Cobb, W.Y., and Johnson, B.R. 1973. Physicochemical properties of peanuts. Pages 209-263 in Peanuts - culture and uses. (Cobb, W.Y. & Johnson, B.R. eds.) American Peanut Research and Education Association Inc, Stone Printing Company, Virginia, USA.

Dubois, M., Giller, K.A., Hamilton, J.K., Rebers, P.A., and Smith, F. 1956. Colorimetric method for determination of sugars and related substances. Analytical Chemistry 28:350-356.

Jambunathan, R., Madhusudhana Raju, S., Subhada P. Barde 1985. Analysis of oil content of groundnuts by nuclear magnetic resonance spectrometry. Journal of the Science of Food and Agriculture. 36:162-166.

Recommended Dietary Allowances. 1980. Committee on dietary allowances : Food and Nutrition Board, 9th ed. National Academy of Sciences, Washington, D.C.

Singh, U., and Jambunathan, R. 1980. Evaluation of rapid methods for the estimation of protein in chickpea (Cicer arietinum L.). Journal of the Science of Food and Agriculture 31:247-254.

Thivend, P., Mercier, C. and Guilbot A. 1972. Determination of starch with glucoamylase. Pages 100-105 in Methods in Carbohydrate Chemistry, Vol VI (Whistler, R.L., BeMiller, J.N. eds.) New York, USA:Academic Press.

Venkatrao, S. and Jogi Pantulu A. 1958. The chemical composition and nutritive value of groundnut (peanut) and its products. Indian Oilseeds Journal 1:322-329.

SECTION II. AMINO ACID COMPOSITION

II. AMINO ACID COMPOSITION

1.0 INTRODUCTION

Groundnut is an excellent source of protein, and the protein content of the seed depends on the genetic make up of the cultivar and the location where it is grown. Groundnut seed having high levels of free amino acids during the early stages of maturation was found to have a high protein content at maturity (Basha et al. 1976). Groundnut protein has higher concentration of acidic amino acids, aspartic and glutamic acids, lower amounts of sulfur-containing amino acids, cystine and methionine, and also lysine, tryptophan and threonine (Basha et al. 1980).

The high levels of free amino acids, such as arginine, have been correlated with off-flavor of immature groundnut. Amino acids like aspartic acid, glutamic acid, phenylalanine, and histidine react with sugars and contribute to the flavor quality of roasted groundnut. The arginine maturity index (AMI) method was proposed to predict the maturity of groundnut (Johnson et al. 1976).

Amino acids influence the nutritional and flavor characteristics of groundnut and hence the determination of amino acid composition of groundnut is necessary. Changes in the percentages of total free amino acids and proteins in the defatted groundnut meal can be used to classify groundnut into immature, intermediate, and mature stages (Basha 1976).

The modelling of roasted peanut flavor from the amino acid and sugar contents has been investigated by Oupadissakoon and Young (1984). Thus, the protein content and free amino acids of groundnut are important factors which determine the maturity and flavor of groundnut.

The major storage proteins of groundnut are arachin and conarachin. Differences in the nutritional value of groundnut are attributed to varying amounts of arachin and conarachin proteins. Of the proteins of groundnut, the basic protein constitutes about 1% of the total seed protein and is rich in lysine, glycine, and methionine, and low in aspartic and glutamic acids (Basha and Pancholy 1982).

2.0 MATERIALS AND METHODS

2.1 Materials

The seven groundnut cultivars, ICGS 1, ICGS 5, ICGS 11, ICGS 21, ICGS 44, including the controls, Kadiri 3 and J 11 grown during the 1985/86 postrainy and 1988 rainy seasons at ICRISAT Center, were analyzed for their amino acid composition. Amino acid determination was carried out both on the whole seed and blanched (seed without the seed coat or testa) seed samples to estimate the influence of seed coat on amino acid composition.

We also investigated the location and environment effects on the amino acid composition. Seed material for these amino acid analyses came from the Quality Studies Trial (QST). Thirteen groundnut cultivars were grown during the 1988 rainy and 1988/89

postrainy seasons, at three locations - ICRISAT Center, Hisar and Dharwad.

Sixty-eight groundnut samples from the 1987 postrainy season that had an oleic to linoleic acid (O/L) ratio of more than 1.6, were also analyzed for their amino acid composition.

2.2 Methods

2.2.1 Preparation of protein hydrolyzates

Fifty mg of the defatted flour was hydrolyzed with 50 ml of 6 N HCl by refluxing for 24 hr. The hydrolyzate was cooled, and evaporated to dryness in a rotary flash evaporator. The residue was washed with water and the procedure was repeated thrice to remove all the acid and dried. The residue was dissolved in 9 ml of 0.2 N sodium citrate buffer (pH 2.2), followed by the addition of 1 ml of 5 u moles/ml norleucine (internal standard) and filtered. One hundred ul of the filtrate was used for amino acid analysis on the (Beckman model 119 CL) amino acid analyzer.

2.2.2 Amino acid analysis

The principle behind the amino acid analysis is the separation of various amino acids by ion exchange chromatography and then quantification of individual amino acids using a colorimetric assay. Groundnut protein was hydrolyzed to free amino acids using 6 N HCl and the mixture of amino acids in protein hydrolyzate was passed through a column of sulfonated polystyrene resin, whereby the individual amino acids get separated (Moore and Stein 1963). The amino acids react with the ninhydrin

Table 6. Amino acid composition (g(100 g)$^{-1}$ protein) of groundnut cultivars, postrainy season 1985/86, ICRISAT Center[1]

Cultivar	ASP	THR	SER	GLU	PRO	GLY	ALA	CYS	VAL	MET	ILE	LEU	TYR	PHE	HIS	LYS	ARG	TOTAL	Protein (%)
ICGS 1	12.46	3.23	5.34	21.97	5.47	6.11	4.42	1.57	4.65	1.38	3.73	6.92	4.55	5.62	3.11	3.98	12.97	107.68	49.60
ICGS 5	12.42	3.09	5.21	22.01	4.57	6.37	4.40	1.32	4.80	1.33	3.86	7.27	4.65	5.84	2.87	4.03	13.50	107.54	49.10
ICGS 11	12.35	3.32	5.49	21.67	4.98	6.10	4.13	1.16	4.51	1.22	3.76	6.84	4.32	5.45	2.74	4.07	12.80	104.91	49.70
ICGS 21	12.70	3.10	5.45	21.55	4.95	6.37	4.25	1.32	4.66	1.23	3.66	7.17	4.52	5.58	2.99	4.06	13.81	106.95	49.00
ICGS 44	12.60	3.14	5.39	21.57	5.26	6.26	4.12	1.29	4.69	1.36	3.64	7.24	4.51	5.81	2.91	4.09	12.89	106.77	49.00
Mean[2]	12.51	3.18	5.38	21.75	5.05	6.24	4.26	1.33	4.66	1.30	3.73	7.09	4.51	5.66	2.92	4.05	13.19		49.30
SE[2]	±0.063	±0.045	±0.049	±0.099	±0.153	±0.059	±0.064	±0.066	±0.046	±0.033	±0.039	±0.087	±0.054	±0.073	±0.062	±0.019	±0.187		±0.153

1. Means of 2 replicates
2. Means and SE of five cultivars

reagent and the color produced is measured using a colorimeter for determining the concentration of amino acids.

3.0 RESULTS AND DISCUSSION

The results of amino acid analysis of whole seed and blanched groundnut seeds of cultivars grown during the 1985/86 postrainy season are shown in Tables 6 and 6A. Data obtained on these samples from the 1988-rainy season are shown in Tables 7 and 7A. The mean protein content of the blanched samples was higher than the whole seed samples in both the seasons. The levels of various essential amino acids and nonessential amino acids did not show large variation among the cultivars for both the seasons. The whole seed samples of both the seasons had higher amounts of threonine and lysine and lower amounts of glutamic acid than the blanched samples. Large differences were observed in the means of serine (5.24 and 4.12), and tyrosine (3.32 and 4.40) between whole seed and blanched samples grown in the rainy season 1988.

The protein contents of the cultivars grown during the postrainy season 1985/86 were higher than those grown in the rainy season 1988. Inspite of this, the postrainy season cultivars had higher amounts of many amino acids than the cultivars of rainy season 1988.

The results of the amino acid composition of the Quality Studies Trial samples from the rainy season 1988 and postrainy season 1988/89 grown at ICRISAT Center, Hisar and Dharwad are

Table 6A. Amino acid composition [g(100 g)$^{-1}$ protein] of blanched groundnut cultivars, postrainy season 1985/86, ICRISAT Center[1]

Cultivar	ASP	THR	SER	GLU	PRO	GLY	ALA	CYS	VAL	MET	ILE	LEU	TYR	PHE	HIS	LYS	ARG	TOTAL	Protein (%)
ICGS 1	12.60	2.91	5.49	23.39	4.97	6.23	4.42	1.32	4.69	1.37	3.93	7.17	4.80	5.74	2.92	3.82	12.99	108.76	52.10
ICGS 5	12.32	2.79	5.13	23.18	4.62	5.70	4.25	1.27	4.60	1.38	3.87	6.87	4.59	5.62	2.72	3.59	12.37	104.87	52.30
ICGS 11	12.31	2.91	5.24	22.02	4.80	5.89	4.31	1.35	4.53	1.21	3.75	6.91	4.47	5.41	2.79	3.72	12.08	103.72	51.40
ICGS 21	12.46	2.79	5.33	22.29	4.63	6.11	4.25	1.34	4.64	1.29	3.90	7.06	4.58	5.63	2.73	3.92	13.15	106.10	51.70
ICGS 44	12.28	2.74	5.37	22.43	5.07	6.00	4.35	1.21	4.69	1.39	3.90	7.09	4.44	5.62	2.88	3.78	12.76	106.00	52.30
Mean[2]	12.39	2.83	5.32	22.66	4.82	5.99	4.32	1.30	4.63	1.33	3.87	7.02	4.58	5.60	2.81	3.78	12.67		52.00
SE[2]	±0.054	±0.035	±0.060	±0.265	±0.090	±0.091	±0.032	±0.026	±0.030	±0.034	±0.031	±0.056	±0.063	±0.054	±0.040	±0.055	±0.197		±0.178

1. Means of two replicates
2. Means and SE of five cultivars

Table 7. Amino acid composition (g(100 g)$^{-1}$ protein) of whole seed groundnut cultivars, rainy season 1988, ICRISAT Center[1]

Cultivar	ASP	THR	SER	GLU	PRO	GLY	ALA	CYS	VAL	MET	ILE	LEU	TYR	PHE	HIS	LYS	ARG	TOTAL	Protein (%)
ICGS 1	11.26	2.50	5.40	21.58	5.65	6.13	4.04	1.21	4.41	1.31	3.57	5.98	3.30	5.35	2.24	4.17	11.34	99.39	41.00
ICGS 5	11.64	2.51	5.21	21.85	5.56	6.10	3.72	1.23	4.38	1.31	3.60	6.36	3.37	5.43	2.33	4.12	11.41	100.08	42.70
ICGS 11	11.67	2.74	5.31	22.24	5.70	6.07	4.08	1.21	4.36	1.29	3.46	6.41	3.21	4.89	2.29	4.17	11.37	100.44	43.00
ICGS 21	11.44	2.54	5.32	21.50	5.97	5.54	4.30	1.26	4.30	1.27	3.28	6.46	3.16	5.27	2.08	4.56	11.07	99.30	39.70
ICGS 44	11.31	2.33	5.37	21.97	6.37	5.47	4.41	1.22	4.17	1.29	3.33	6.41	3.34	5.27	2.18	4.47	11.36	100.24	37.60
Controls																			
Kadiri 3	11.18	2.40	5.09	21.29	6.40	5.51	4.27	1.26	4.03	1.26	3.28	6.30	3.38	4.96	2.21	4.40	11.28	98.47	37.70
J 11	11.21	2.25	5.04	21 88	6.30	6.42	4.12	1.24	4.13	1.21	3.33	6.48	3.50	5.35	2.12	4.47	11.47	100.48	37.40
Mean[2]	11.38	2.47	5.24	21.76	5.99	5.89	4.13	1.23	4.25	1.28	3.41	6.34	3.32	5.26	2.21	4.33	11.33	99.84	39.87
SE[2]	±0.076	±0.060	±0.053	±0.121	±0.137	±0.142	±0.085	±0.008	±0.055	±0.013	±0.051	±0.065	±0.043	±0.079	±0.034	±0.068	±0.048	±0.281	±0.914

1. Means of two replicates
2. Means and SE of seven cultivarsw

Table 7 A. Amino acid composition [g(100g)$^{-1}$ protein] of blanched groundnut cultivars, rainy season 1988, ICRISAT Center

Cultivar	ASP	THR	SER	GLU	PRO	GLY	ALA	CYS	VAL	MET	ILE	LEU	TYR	PHE	HIS	LYS	ARG	TOTAL	Protein (%)
ICGS 1	11.18	2.21	4.76	22.40	5.90	6.27	4.23	1.24	4.47	1.34	3.83	6.69	4.36	5.14	2.25	4.04	11.52	101.55	41.25
ICGS 5	11.22	2.05	4.52	22.09	5.83	6.07	4.31	1.26	4.22	1.27	3.50	6.44	4.32	5.19	2.16	3.92	11.15	99.50	42.05
ICGS 11	11.05	2.07	4.69	22.01	5.47	6.08	4.37	1.29	4.37	1.20	3.54	6.52	4.30	5.28	2.20	3.98	11.20	99.63	43.65
ICGS 21	11.26	2.24	4.72	21.92	5.51	5.97	4.33	1.30	4.28	1.23	3.59	6.48	4.34	5.26	2.11	4.02	11.35	99.84	38.90
ICGS 44	11.16	2.16	4.89	21.89	5.55	6.21	4.18	1.31	4.14	1.17	3.27	6.35	4.49	5.24	2.29	4.27	11.35	100.10	42.15
Controls																			
Kadiri 3	11.38	2.21	4.65	21.88	5.65	5.65	4.52	1.30	4.21	1.25	3.09	6.39	4.32	5.16	2.05	4.26	11.05	98.97	42.65
J 11	11.08	2.15	4.81	22.19	5.97	5.87	4.21	1.28	4.41	1.31	3.62	6.59	4.71	5.20	2.01	4.31	11.31	100.79	40.35
Mean[2]	11.19	2.15	4.12	22.05	5.70	5.98	4.31	1.28	4.27	1.25	3.46	6.55	4.40	5.21	2.15	4.11	11.28	100.10	41.56
SE[2]	±0.042	±0.027	±0.045	±0.072	±0.076	±0.069	±0.044	±0.009	±0.045	±0.023	±0.089	±0.050	±0.056	±0.020	±0.039	±0.061	±0.059	±0.327	±0.591

1. Means of two replicates
2. Means and SE of seven cultivarsw

shown in the Tables 8-13. The groundnut samples from the 1988 rainy season from Hisar showed higher protein content as compared to the protein values obtained from the other two locations. Groundnut cultivars from the 1988 postrainy season, however, showed higher protein content from Dharwad (Table 13). There does not appear to be much variation in the amino acid composition among the cultivars from the three locations. It is also evident that groundnut protein is deficient in many essential amino acids like threonine, methionine and cystine, lysine and isoleucine.

It has been reported that typical amino acids (T) such as aspartic acid, glutamic acid, histidine and phenylalanine are associated with the production of typical roasted groundnut flavor. The atypical amino acids (AT) such as threonine, tyrosine, lysine, and arginine are associated with production of off-flavor roasted groundnut flavor (Pattee and Young, 1987). Therefore, higher O/L and T/AT ratios can be considered as preferred quality characteristics of confectionery groundnut cultivars.

We had selected 68 groundnut cultivars grown during the 1987/88 postrainy season, having a O/L ratio of more than 1.6, for their amino acid analysis as shown in Table 14. From the amino acid composition, the T/AT ratios were calculated, and ratio of 1.8 or above is reported to be indicative of good roasting flavor potential (Pattee and Young, 1987). The correlation between T/AT and O/L ratios was nonsignificant

Table 8. Amino acid composition [g(100 g)$^{-1}$ protein] of groundnut cultivars from quality studies trial, rainy season 1988, ICRISAT Center

ICG No.	ASP	THR	SER	GLU	PRO	GLY	ALA	CYS	VAL	MET	ILE	LEU	TYR	PHE	HIS	LYS	ARG	TOTAL	Protein (%)
2411	10.71	2.97	4.74	20.26	5.51	5.74	4.04	1.36	4.05	1.31	3.99	6.97	3.82	4.92	2.31	4.23	10.91	97.84	32.65
7625	10.80	2.74	4.92	21.89	5.50	5.39	4.69	1.27	3.67	1.32	3.86	6.97	3.89	5.23	2.44	4.04	11.09	99.71	42.40
7637	10.73	2.83	5.00	21.76	5.49	6.15	4.59	1.21	4.05	1.27	3.99	7.13	3.74	5.43	2.49	4.16	11.56	101.58	39.15
1171	10.64	2.41	4.75	21.91	6.00	5.65	4.25	1.27	3.98	1.21	3.84	6.94	3.71	5.57	2.29	4.29	11.07	99.78	34.80
6706	10.90	2.55	5.01	21.58	5.87	3.51	4.19	1.29	3.73	1.34	3.89	7.04	3.72	5.42	2.39	4.21	11.36	98.30	38.90
3509	10.74	2.53	4.82	21.76	6.00	5.50	4.09	1.24	3.86	1.29	4.00	7.11	3.69	5.29	2.34	4.23	11.36	99.83	38.75
6288	10.83	2.56	5.08	21.81	5.78	5.66	4.06	1.35	3.98	1.30	3.99	7.37	3.77	5.23	2.37	4.43	11.69	101.03	36.75
8047	10.89	2.56	4.87	21.71	6.02	5.59	4.06	1.27	3.71	1.28	4.08	7.00	3.60	5.14	2.34	4.00	11.21	99.33	42.60
5369	10.71	2.61	4.82	21.90	6.13	5.47	4.17	1.28	3.83	1.29	4.03	7.03	3.69	5.37	2.31	3.93	11.14	99.71	41.15
5856	10.69	2.43	4.98	22.00	6.03	5.38	4.17	1.29	3.73	1.31	4.00	6.97	3.39	5.31	2.38	3.97	11.40	99.43	42.20
ICGS 21	11.14	2.57	4.95	22.01	5.57	5.88	4.27	1.39	3.84	1.33	3.95	6.90	3.69	5.38	2.39	4.00	11.10	100.36	37.15
JL 24	10.98	2.46	5.04	22.15	6.36	5.38	4.17	1.29	3.95	1.36	3.89	7.19	3.54	5.48	2.32	4.19	11.34	101.09	42.20
ICGS 11	10.87	2.53	5.06	22.04	5.52	5.95	4.20	1.32	3.92	1.32	3.47	6.78	3.81	5.02	2.28	4.41	11.12	99.62	36.95
Mean	10.82	2.60	4.93	21.75	5.83	5.48	4.23	1.30	3.87	1.30	3.92	7.03	3.70	5.29	2.36	4.16	11.24	99.78	38.88
SE	±0.038	±0.045	±0.032	±0.131	±0.080	±0.176	±0.055	±0.014	±0.036	±0.010	±0.042	±0.041	±0.036	±0.051	±0.017	±0.044	±0.053	±0.301	±0.873

Table 9. Amino acid composition (g(100 g)$^{-1}$ protein) of groundnut cultivars from quality studies trial, rainy season 1988, Hisar

ICG No.	ASP	THR	SER	GLU	PRO	GLY	ALA	CYS	VAL	MET	ILE	LEU	TYR	PHE	HIS	LYS	ARG	TOTAL	Protein (%)
2411	10.97	2.29	5.05	22.08	5.37	5.45	4.16	1.24	4.02	1.36	3.56	6.71	3.61	5.64	2.36	3.91	11.38	99.16	44.80
7625	10.91	2.31	4.83	21.28	5.55	5.79	4.36	1.39	4.03	1.37	3.31	6.57	3.56	5.15	2.16	3.90	11.43	97.90	45.10
7637	10.86	2.26	4.91	21.47	5.80	5.55	4.17	1.33	4.30	1.36	3.43	6.61	3.80	5.61	2.27	3.89	11.18	98.80	45.30
1171	11.00	2.21	5.05	21.99	5.72	5.07	4.00	1.31	4.06	1.36	3.05	6.61	3.41	5.05	2.24	3.66	10.94	96.73	48.00
6706	11.03	2.23	5.05	20.87	5.37	5.06	4.06	1.27	4.29	1.30	3.42	6.37	3.49	5.64	2.17	3.52	11.19	96.33	50.00
3509	11.01	2.34	5.03	21.00	5.46	5.16	4.04	1.26	4.37	1.39	3.51	6.00	3.36	5.15	2.24	3.57	11.14	96.03	49.50
6288	11.22	2.28	5.01	21.87	5.01	5.58	4.05	1.22	3.98	1.35	3.32	5.83	3.66	5.63	2.16	3.86	11.34	96.37	49.40
8047	11.01	2.29	4.85	21.33	5.41	4.95	4.06	1.22	3.97	1.40	3.22	5.94	3.36	4.99	2.21	3.97	11.09	95.27	46.70
5369	11.03	2.37	5.11	21.58	5.59	5.51	4.02	1.33	4.07	1.40	3.39	6.13	3.29	4.76	2.14	4.07	11.10	96.89	37.75
5856	11.17	2.69	5.41	22.00	5.24	6.01	4.05	1.33	4.61	1.37	3.37	6.42	3.48	5.13	2.28	3.95	11.48	99.99	47.85
ICGS 21	11.05	2.24	4.85	21.46	5.49	5.36	4.00	1.26	3.98	1.34	3.30	6.06	3.27	4.94	2.05	4.31	11.07	96.03	38.40
JL 24	11.07	2.16	5.05	21.41	6.04	5.67	4.21	1.29	3.82	1.31	3.41	6.41	3.99	4.94	2.13	3.84	11.59	98.34	52.40
ICGS 11	11.41	2.36	5.04	21.48	5.44	5.17	4.02	1.33	3.85	1.40	3.44	6.28	3.83	4.96	2.06	4.18	11.18	99.43	46.30
Mean	11.06	2.32	5.02	21.52	5.50	5.41	4.09	1.29	4.10	1.36	3.36	6.30	3.55	5.20	2.19	3.90	11.24	97.41	46.27
SE	±0.039	±0.036	±0.042	±0.104	±0.071	±0.088	±0.029	±0.014	±0.062	±0.009	±0.036	±0.080	±0.062	±0.098	±0.024	±0.062	±0.052	±0.414	±1.178

Table 10. Amino acid composition [g(100 g)$^{-1}$ protein] of groundnut cultivars from quality studies trial, rainy season 1988, Dharwad

ICG No.	ASP	THR	SER	GLU	PRO	GLY	ALA	CYS	VAL	MET	ILE	LEU	TYR	PHE	HIS	LYS	ARG	TOTAL	Protein (%)
2411	11.28	2.34	5.14	21.63	5.39	4.86	4.11	1.29	3.83	1.40	3.67	6.08	3.81	5.15	2.14	4.27	11.66	97.65	39.60
7625	11.03	2.04	5.21	21.41	5.12	4.84	4.05	1.24	3.78	1.34	3.34	6.06	3.70	4.89	2.19	4.07	11.55	95.86	46.25
7637	11.18	2.11	4.85	21.30	6.09	5.34	3.81	1.18	3.88	1.22	3.34	7.17	3.99	5.42	2.32	4.17	11.96	99.33	44.30
1171	11.27	2.16	5.30	22.11	6.06	4.79	3.76	1.26	3.77	1.20	3.44	7.06	3.73	5.54	2.29	4.11	11.96	99.81	60.55
6706	11.18	2.15	5.14	21.94	6.21	5.30	4.50	1.29	3.78	1.30	3.73	6.81	3.54	5.18	2.25	3.49	11.69	99.48	48.25
3509	11.17	2.25	5.18	22.00	6.00	5.00	4.81	1.18	4.13	1.26	3.80	7.10	3.63	5.59	2.29	4.05	11.40	100.84	48.35
6288	11.62	2.21	5.19	22.08	6.46	5.07	4.68	1.34	4.03	1.39	3.71	7.08	3.51	5.38	2.25	4.03	11.61	101.44	47.65
8047	11.09	2.13	5.22	22.09	6.09	4.89	4.79	1.32	4.14	1.27	3.72	6.97	3.69	5.01	2.10	4.17	11.44	100.13	46.95
5369	11.05	2.36	5.09	21.47	6.10	5.38	4.69	1.21	4.15	1.27	3.71	6.13	3.49	5.15	2.29	3.98	11.68	99.20	35.90
5856	11.23	2.14	5.37	22.10	5.49	5.42	4.23	1.21	4.14	1.31	3.33	7.01	3.48	5.08	2.17	3.96	11.60	99.07	47.10
ICGS 21	11.26	2.36	5.06	21.13	5.51	6.00	3.96	1.29	4.00	1.28	3.59	6.40	3.67	5.20	2.30	3.92	11.59	98.52	41.45
JL 24	11.20	2.35	5.31	21.99	5.47	6.10	4.17	1.26	4.81	1.33	4.00	6.51	3.57	5.33	2.31	4.01	11.49	101.21	42.75
ICGS 11	11.61	2.40	5.01	21.90	5.30	6.36	4.21	1.29	4.25	1.30	3.87	6.95	3.52	5.42	2.34	4.20	11.43	101.36	41.04
Mean	11.24	2.23	5.16	21.13	5.79	5.34	4.29	1.26	4.05	1.03	3.62	6.72	3.64	5.26	2.25	4.03	11.57	99.53	43.84
SE	±0.051	±0.033	±0.038	±0.096	±0.117	±0.144	±0.101	±0.014	±0.078	±0.016	±0.061	±0.117	±0.041	±0.058	±0.021	±0.053	±0.055	±0.441	±1.101

Table 11. Amino acid composition [g(100 g)$^{-1}$ protein] of groundnut cultivars from quality studies trial, postrainy season, 1988/89 ICRISAT Center

ICG No.	ASP	THR	SER	GLU	PRO	GLY	ALA	CYS	VAL	MET	ILE	LEU	TYR	PHE	HIS	LYS	ARG	TOTAL	Protein (%)
2411	11.37	2.51	5.12	21.71	5.91	6.00	4.35	1.11	4.36	1.51	3.42	7.00	4.35	5.31	2.15	4.00	11.19	101.37	40.80
7625	11.16	2.63	5.01	21.33	5.64	6.25	4.53	1.27	4.42	1.30	3.23	6.96	4.32	5.18	2.17	4.05	11.39	100.86	44.50
7637	11.32	2.54	5.03	21.75	5.46	6.30	4.58	1.29	4.59	1.40	3.14	7.05	4.37	5.09	2.23	4.16	11.28	101.58	42.00
1171	11.40	2.38	5.14	21.95	5.60	6.08	4.60	1.26	4.31	1.42	3.26	7.03	4.29	5.27	2.24	4.04	11.27	101.15	44.35
6706	11.16	2.41	5.16	22.00	5.37	6.06	4.31	1.19	4.22	1.46	3.27	7.01	4.34	5.26	2.25	4.09	11.43	100.99	41.70
3509	11.19	2.39	5.14	22.01	5.50	6.29	4.50	1.26	4.47	1.39	3.14	7.08	4.25	5.27	2.16	3.89	11.24	101.17	46.45
6288	11.36	2.26	5.07	22.02	5.41	6.14	4.46	1.30	4.36	1.34	3.19	7.15	4.24	5.32	2.09	4.14	11.32	101.17	42.65
8047	11.02	2.39	5.10	21.85	5.39	5.99	4.36	1.33	4.24	1.30	3.03	6.94	4.09	5.40	2.20	3.79	11.25	99.67	49.70
5369	11.06	2.26	5.05	21.97	5.45	6.14	4.44	1.29	4.26	1.28	2.96	7.07	4.06	5.31	2.21	4.04	11.36	100.22	41.20
5856	11.15	2.29	5.08	22.04	5.50	5.94	4.54	1.24	4.34	1.24	3.26	7.09	4.08	5.24	2.19	4.09	11.39	100.70	40.75
ICGS 21	11.19	2.21	5.04	21.87	5.53	6.14	4.48	1.28	4.19	1.30	3.19	6.94	4.13	5.17	2.17	4.32	11.21	100.36	35.65
JL 24	11.17	2.20	5.05	21.90	5.46	5.99	4.36	1.24	4.11	1.29	3.10	7.04	4.04	5.10	2.09	4.20	11.39	99.73	44.35
ICGS 11	11.16	2.26	5.08	21.95	5.31	5.96	4.39	1.27	4.09	1.34	3.19	7.14	4.09	5.01	2.09	3.95	11.34	99.62	41.90
Mean	11.21	2.36	5.08	21.87	5.49	6.10	4.44	1.26	4.31	1.35	3.18	7.04	4.20	5.23	2.17	4.06	11.31	100.70	42.77
SE	±0.033	±0.037	±0.013	±0.053	±0.042	±0.034	±0.023	±0.015	±0.039	±0.022	±0.032	±0.019	±0.035	±0.030	±0.015	±0.038	±0.022	±0.187	±0.924

Table 12. Amino acid composition [g(100 g)$^{-1}$ protein] of groundnut cultivars from quality studies trial, postrainy season 1988/89, Hisar

ICG No.	ASP	THR	SER	GLU	PRO	GLY	ALA	CYS	VAL	MET	ILE	LEU	TYR	PHE	HIS	LYS	ARG	TOTAL	Protein (%)
2411	11.07	2.23	5.24	21.75	5.42	5.86	4.41	1.17	4.32	1.42	3.36	6.94	4.35	5.09	2.21	4.27	11.69	100.80	39.20
7625	11.36	2.38	5.30	21.74	5.35	5.87	4.21	1.32	4.03	1.36	3.20	7.00	4.14	4.99	2.01	3.96	11.41	99.63	41.80
7637	11.08	2.22	5.24	21.62	5.36	5.86	4.28	1.22	4.09	1.27	3.44	6.94	4.25	4.89	2.34	4.16	11.29	99.55	36.60
1171	11.48	2.41	5.12	21.69	5.37	5.97	4.01	1.33	4.34	1.35	3.36	6.87	4.08	4.95	2.25	4.29	11.31	100.18	38.70
6706	11.27	2.42	5.07	21.79	5.41	6.01	4.13	1.24	4.22	1.37	3.37	7.01	4.00	4.93	2.26	3.84	11.69	100.03	42.75
3509	11.34	2.24	4.89	21.88	5.39	5.79	4.27	1.19	4.25	1.20	3.13	6.87	4.05	4.97	2.24	3.79	11.38	99.87	42.55
6288	11.40	2.23	4.77	21.77	5.50	5.70	4.26	1.22	4.18	1.29	3.32	6.91	4.04	4.93	2.27	3.87	11.29	98.96	41.60
8047	11.49	2.27	5.32	21.87	5.19	6.04	4.27	1.27	4.18	1.37	3.37	7.00	4.33	4.90	2.25	4.10	11.29	100.42	43.60
5369	11.21	2.21	5.06	21.80	5.23	6.18	4.28	1.18	4.03	1.21	3.43	6.92	4.11	5.07	2.25	4.31	11.24	99.72	36.55
5856	11.21	2.29	5.05	21.88	5.04	5.91	4.38	1.24	4.07	1.27	3.24	6.76	4.05	4.96	2.12	4.17	11.27	98.91	38.50
ICGS 21	11.32	2.15	5.23	21.27	5.64	5.97	4.26	1.21	4.27	1.27	3.14	6.91	4.26	4.87	2.14	4.57	11.26	99.74	34.85
JL 24	11.05	2.35	5.05	21.81	5.61	5.91	4.35	1.28	4.35	1.21	3.01	6.92	4.33	4.92	2.14	3.94	11.35	99.58	45.30
ICGS 11	11.05	2.15	4.84	21.47	5.34	5.87	4.41	1.19	4.27	1.26	3.28	6.73	4.43	4.84	2.22	4.30	11.30	98.95	39.70
Mean	11.26	2.27	5.09	21.72	5.37	5.92	4.27	1.24	4.20	1.30	3.28	6.91	4.19	4.95	2.21	4.12	11.36	99.72	40.52
SE	±0.044	±0.025	±0.049	±0.049	±0.045	±0.033	±0.031	±0.014	±0.032	±0.020	±0.040	±0.023	±0.040	±0.020	±0.024	±0.064	±0.043	±0.157	±1.027

Table 13. Amino acid composition (g(100 g)$^{-1}$ protein) of groundnut cultivars from quality studies trial, postrainy season 1988/89, Dharwad

ICG. No.	ASP	THR	SER	GLU	PRO	GLY	ALA	CYS	VAL	MET	ILE	LEU	TYR	PHE	HIS	LYS	ARG	TOTAL	Protein (%)
2411	11.24	2.26	5.10	21.66	5.47	5.87	4.39	1.19	4.34	1.35	3.36	7.03	4.47	4.87	2.16	4.24	11.29	100.29	40.70
7625	11.05	2.28	4.89	22.00	5.31	5.99	4.05	1.21	4.32	1.36	3.30	6.89	4.31	4.77	2.13	3.84	11.16	98.86	50.55
7637	11.04	2.35	4.79	21.83	5.49	5.84	4.39	1.17	4.45	1.41	3.24	6.99	4.19	4.92	2.09	4.23	11.14	99.56	43.50
1171	11.13	2.34	4.83	22.07	5.51	5.71	4.19	1.19	4.55	1.37	3.19	6.96	4.46	4.97	2.08	4.00	11.17	99.72	45.45
6706	11.17	2.22	4.83	21.69	5.69	5.69	4.47	1.19	4.35	1.41	3.27	7.05	4.26	4.84	2.12	3.82	11.41	99.68	51.60
3509	11.25	2.28	4.87	21.44	5.80	5.81	4.41	1.23	4.42	1.40	3.21	7.04	4.28	4.69	2.09	3.99	11.49	99.75	49.50
6288	11.19	2.29	5.04	21.68	5.69	5.59	4.59	1.26	4.46	1.36	3.28	6.97	4.29	4.60	2.07	4.03	11.37	99.75	48.30
8047	11.33	2.36	5.18	22.05	5.49	5.63	4.48	1.36	4.23	1.33	3.17	7.03	4.40	4.53	2.04	4.17	11.17	99.95	48.70
5369	11.08	2.34	5.12	21.67	5.49	5.83	4.42	1.34	4.27	1.23	3.32	7.00	4.36	4.39	2.26	4.26	11.14	99.52	43.60
5856	11.12	2.19	5.22	21.78	5.41	5.99	4.28	1.29	4.27	1.24	3.29	7.05	4.17	4.38	2.27	4.06	11.07	99.08	43.55
ICGS 21	11.44	2.26	5.30	21.49	5.39	5.63	4.17	1.21	4.17	1.22	3.31	6.89	4.04	4.28	2.27	4.35	11.03	98.45	38.80
JL 24	11.31	2.25	5.31	22.04	5.43	5.41	4.14	1.26	4.19	1.27	3.35	7.00	4.24	4.41	2.26	3.91	11.25	99.03	51.10
ICGS 11	11.47	2.39	5.17	21.70	5.29	5.46	4.11	1.24	4.39	1.21	3.22	6.92	4.14	4.53	2.21	4.25	11.49	99.19	43.95
Mean	11.22	2.29	5.05	21.78	5.50	5.73	4.32	1.25	4.34	1.32	3.27	6.99	4.28	4.63	2.16	4.09	11.24	99.43	46.08
SE	±0.039	±0.016	±0.052	±0.058	±0.041	±0.051	±0.047	±0.017	±0.031	±0.021	±0.017	±0.16	±0.035	±0.064	±0.026	±0.048	±0.043	±0.138	±1.150

Table 14. Amino acid composition (g(100 g)$^{-1}$ protein)of selected groundnut cultivars having O/L ratio of more than 1.60, 1987/88 postrainy season, ICRISAT Center

Cultivar	ASP	THR	SER	GLU	PRO	GLY	ALA	CYS	VAL	MET	ILE	LEU	TYR	PHE	HIS	LYS	ARG	PR	TOTAL	O/L ratio	% AT
ECGVT 1	11.96	2.68	5.00	20.47	4.75	5.87	4.11	1.40	4.34	1.35	3.77	6.89	4.40	5.18	2.37	3.72	11.37	99.63	44.10	1.75	1.80
ECGVT 2	12.30	2.73	5.08	20.69	4.40	5.81	4.25	1.36	4.18	1.24	3.68	6.88	4.10	5.18	2.29	3.32	11.28	98.77	46.15	1.77	1.89
ECGVT 4	12.54	2.66	5.19	21.31	4.62	5.45	3.72	1.36	4.45	1.28	3.75	7.16	4.28	5.23	2.41	3.44	11.78	100.63	50.45	1.86	1.87
ECVGT 17	12.96	2.92	5.27	21.75	4.80	5.41	3.47	1.27	4.33	1.11	3.49	7.10	4.34	5.31	2.35	3.38	12.24	101.50	53.10	1.64	1.85
ECGVT 20	12.49	2.67	5.38	21.90	4.81	5.38	3.84	1.29	4.34	1.21	3.81	6.79	4.11	5.30	2.50	3.51	11.81	101.14	45.85	1.66	1.91
ECGVT 21	12.95	2.69	5.12	21.44	4.73	5.31	3.69	1.31	4.13	1.31	3.65	7.13	4.36	5.29	2.40	3.45	12.02	100.98	49.50	1.89	1.87
USA 1	12.95	2.52	4.96	21.60	4.79	5.54	3.70	1.31	4.03	1.22	3.47	7.02	4.28	5.37	2.38	3.48	11.57	100.19	46.30	1.64	1.94
USA 2	12.47	2.64	5.27	21.63	4.84	6.00	3.84	1.41	4.06	1.33	3.73	7.06	4.31	5.48	2.59	3.71	11.67	101.84	45.30	1.93	1.91
USA 5	12.42	2.61	5.16	22.00	4.80	5.32	4.06	1.43	4.27	1.30	3.63	6.94	4.33	5.50	2.54	3.70	11.41	101.02	45.50	1.63	1.94
USA 6	12.15	2.21	5.39	21.71	4.67	5.40	3.89	1.35	4.39	1.21	3.29	6.79	4.47	5.57	2.33	3.76	11.85	100.43	47.15	1.59	1.87
USA 9	12.27	2.16	5.12	21.61	4.62	5.99	3.87	1.30	4.21	1.14	3.82	6.90	4.54	5.60	2.30	3.87	11.90	101.22	49.00	1.58	1.86
USA 14	12.36	2.82	5.00	20.92	4.94	5.96	3.70	1.34	4.23	1.21	3.85	7.00	4.49	5.66	2.33	3.74	11.72	101.27	49.85	2.33	1.81
USA 18	12.57	2.44	5.10	21.35	5.15	6.09	4.22	1.48	4.05	1.19	3.47	7.35	4.42	5.20	2.16	3.73	11.46	101.43	48.35	1.67	1.87
USA 31	12.31	2.31	5.00	21.49	5.00	6.00	4.07	1.39	4.01	1.20	3.49	7.01	4.29	5.09	2.17	3.89	11.36	100.08	45.75	1.74	1.88
USA 32	12.74	2.39	5.29	21.41	5.03	5.94	4.21	1.19	4.16	1.19	3.72	7.27	4.26	5.27	2.29	3.62	11.87	101.85	48.40	1.76	1.88
USA 35	12.41	2.61	5.15	20.40	4.79	5.91	4.13	1.32	3.93	1.27	3.53	6.90	4.22	5.14	2.42	3.57	12.04	99.74	50.00	2.25	1.80
USA 37	12.86	2.48	5.15	21.99	4.68	6.22	4.32	1.27	4.37	1.10	3.76	7.27	4.33	5.35	2.52	3.60	11.89	103.14	48.45	2.24	1.92
USA 38	12.42	2.51	5.14	20.84	4.73	5.88	4.30	1.26	4.36	1.26	3.60	7.00	4.15	5.16	2.38	3.56	11.62	100.17	46.95	1.76	1.87
USA 39	12.05	2.30	5.20	21.41	4.56	5.89	4.26	1.26	4.16	1.16	3.42	6.99	4.01	5.31	2.12	3.58	12.00	99.68	49.00	1.63	1.87
USA 40	12.53	2.45	5.12	20.88	4.56	5.69	4.27	1.30	4.35	1.21	3.59	7.00	4.05	5.21	2.22	3.69	11.90	100.09	45.15	1.73	1.85
USA 44	12.61	2.40	5.09	21.00	4.70	5.81	4.25	1.36	4.11	1.16	3.28	7.01	4.09	5.24	2.37	3.77	11.94	100.19	48.50	1.60	1.86
USA 50	12.76	2.36	5.02	21.32	4.65	5.79	4.28	1.29	4.24	1.20	3.74	7.00	4.29	5.27	2.35	3.56	11.65	100.77	49.40	1.98	1.91
USA 53	12.06	2.38	5.13	22.00	4.51	6.16	4.67	1.29	4.16	1.32	3.49	7.15	4.18	5.28	2.70	3.89	12.25	102.62	47.80	2.33	1.85
USA 58	12.11	2.34	5.05	21.68	4.55	6.25	4.48	1.35	4.14	1.21	3.32	6.99	4.15	5.06	2.51	6.29	11.58	101.06	44.70	1.76	1.85
USA 61	11.97	2.48	4.97	20.48	4.98	6.04	4.45	1.37	4.18	1.36	3.49	7.20	4.48	5.29	2.27	4.00	11.73	100.74	46.95	1.72	1.76
USA 62	11.99	2.37	4.98	20.75	5.02	5.90	4.32	1.41	4.25	1.27	3.59	6.91	4.49	5.37	2.28	3.65	11.78	100.33	52.05	1.58	1.81
USA 65	12.03	2.30	5.09	21.18	4.86	6.03	4.39	1.47	4.24	1.27	3.69	6.95	4.41	5.20	2.34	3.79	12.00	101.23	50.40	1.60	1.91
USA 74	11.38	2.48	5.00	21.51	4.51	6.04	3.97	1.22	4.40	1.15	3.62	6.77	4.26	5.18	2.08	3.71	11.02	98.30	49.60	1.63	1.87
PCGVT 3	12.17	2.41	5.17	21.50	4.89	6.06	4.36	1.42	4.30	1.31	3.69	7.00	4.44	5.33	2.38	3.81	11.95	102.19	44.45	1.66	1.83
PCGVT 4	12.15	2.44	5.07	21.21	4.68	6.13	4.07	1.32	4.35	1.39	3.56	6.88	4.25	5.27	2.38	3.67	11.91	100.73	47.30	1.69	1.84
PCGVT 7	12.04	2.52	5.16	21.47	4.79	6.08	4.37	1.40	4.29	1.35	3.69	7.00	4.45	5.32	2.50	3.69	11.97	102.09	47.35	1.66	1.83
PCGVT 11	12.05	2.44	5.05	21.41	4.65	5.91	4.27	1.37	4.30	1.29	3.63	6.85	4.20	5.09	2.58	3.75	11.99	100.83	49.20	1.96	1.84
PCGVT 12	12.16	2.48	5.32	21.16	4.66	6.19	4.31	1.41	4.39	1.29	3.70	7.11	4.32	5.17	2.38	3.58	12.20	101.83	47.10	1.90	1.81
PCGVT 13	12.13	2.59	5.22	21.29	4.80	5.99	4.44	1.37	4.37	1.28	3.81	7.01	4.47	5.33	2.40	3.36	12.21	102.07	48.60	1.66	1.82
PCGVT 14	12.15	2.58	5.28	21.20	5.03	6.04	4.36	1.40	4.55	1.26	3.87	7.21	4.44	5.37	2.50	3.69	11.97	102.90	46.80	1.87	1.82
PCGVT 15	11.91	2.36	5.08	21.04	4.61	5.68	4.36	1.31	4.51	1.25	3.90	7.20	4.09	5.06	2.43	3.69	11.81	100.29	47.10	1.61	1.84
PCGVT 16	12.01	2.44	4.65	21.54	4.94	6.04	4.27	1.46	4.17	1.29	3.82	7.09	4.36	5.35	2.46	3.82	12.24	101.95	46.05	1.71	1.81
PCGVT 17	11.99	2.38	4.74	21.47	4.42	6.07	4.14	1.33	4.24	1.23	3.67	7.02	4.32	5.38	2.37	3.80	11.92	100.49	48.70	1.86	1.84

Table 14 (Contd). Amino acid composition (g(100 g)$^{-1}$ protein)of selected groundnut cultivars having O/E ratio of more than 1.60, 1987/88 postrainy season, ICRISAT Center

Cultivar	ASP	THR	SER	GLU	PRO	GLY	ALA	CYS	VAL	MET	ILE	LEU	TYR	PHE	HIS	LYS	ARG	TOTAL	PR	O/E	P/A
PCGVT 18	12.14	2.50	5.00	21.68	4.64	5.88	4.06	1.27	4.23	1.24	3.68	6.90	4.28	5.29	2.33	3.71	12.09	100.92	45.70	2.00	1.84
PCGVT 19	12.14	2.52	5.16	21.52	4.53	5.84	4.20	1.36	4.36	1.35	3.28	7.03	4.31	5.41	2.38	3.92	12.01	101.32	48.05	1.83	1.82
PCGVT 22	12.23	2.51	5.06	22.29	4.64	5.91	4.29	1.41	4.31	1.25	3.45	7.19	4.21	5.36	2.37	3.80	12.28	102.56	47.30	1.81	1.85
PCGVT 24	12.37	2.58	5.17	21.84	4.70	5.71	4.09	1.41	4.01	1.35	3.35	7.05	4.09	5.21	2.27	4.13	12.25	101.58	47.05	1.76	1.81
PCGVT 26	11.91	2.39	5.07	21.22	4.52	5.86	4.11	1.37	4.09	1.25	3.45	6.64	4.13	5.05	2.38	3.81	12.29	99.54	48.85	1.87	1.79
PCGVT 27	12.15	2.57	5.04	21.42	4.90	5.68	4.07	1.43	4.27	1.26	3.19	7.07	4.18	5.28	2.27	3.89	12.09	100.76	48.15	1.72	1.81
PCGVT 28	11.73	2.57	5.12	21.30	4.92	5.80	4.03	1.41	4.24	1.24	3.38	7.08	4.13	5.26	2.24	4.07	12.18	100.70	46.05	1.58	1.77
PCGVT 29	11.94	2.53	4.69	21.85	5.08	5.87	4.15	1.41	4.07	1.25	3.29	7.06	4.09	5.31	2.04	4.27	12.10	101.00	43.15	1.57	1.79
PCGVT 31	11.63	2.47	5.03	21.67	4.67	5.76	4.04	1.47	4.31	1.21	3.09	7.24	4.21	5.07	2.29	4.17	12.31	100.64	44.00	1.63	1.76
PCGVT 32	12.19	2.54	4.38	21.42	4.47	5.96	3.55	1.20	4.32	1.20	3.02	6.69	4.07	5.01	2.14	3.56	12.31	97.58	51.95	2.00	1.85
PCGVT 34	11.87	2.46	4.45	21.69	4.84	6.26	4.32	1.36	4.07	1.24	4.01	7.03	4.26	4.90	2.14	3.61	12.11	100.62	51.40	1.81	1.81
PCGVT 35	12.10	2.32	4.49	21.59	5.04	5.59	4.34	1.41	4.07	1.21	3.76	6.54	4.25	5.12	1.98	4.07	11.65	99.53	43.30	1.71	1.83
PCGVT 36	11.81	2.12	5.02	22.09	4.88	5.74	4.26	1.40	3.94	1.20	3.71	6.52	4.25	5.13	2.23	3.87	11.26	99.43	50.85	2.04	1.92
PCVGT 38	11.91	2.10	5.05	21.76	4.81	5.98	4.28	1.43	3.90	1.24	3.71	6.66	4.25	5.10	2.20	3.88	11.40	99.48	48.80	2.28	1.89
PCGVT 40	11.40	2.05	4.80	22.00	4.91	5.91	4.22	1.43	3.92	1.21	3.63	6.63	4.09	5.09	2.26	3.92	11.49	98.96	45.15	1.82	1.89
PCGVT 41	11.46	2.19	5.27	21.93	5.05	5.95	4.31	1.37	4.08	1.25	3.70	6.49	4.31	5.04	2.01	4.21	11.01	99.63	42.25	1.91	1.86
PCGVT 42	11.43	2.13	5.31	21.65	5.10	6.07	4.35	1.41	4.28	1.26	3.97	7.00	4.27	5.00	2.02	4.08	11.09	100.42	45.55	1.61	1.86
PCGVT 43	11.63	2.14	4.82	21.43	5.34	5.81	4.39	1.39	3.95	1.23	3.96	6.82	4.09	5.15	2.12	4.30	11.12	99.68	43.70	1.78	1.86
PCGVT 44	11.74	2.03	4.82	21.68	5.04	5.91	4.23	1.43	4.16	1.34	3.69	6.85	4.09	5.04	2.09	3.91	11.25	99.30	45.65	1.67	1.91
PCGVT 45	11.36	1.98	4.78	21.28	4.97	5.89	4.09	1.36	4.18	1.21	3.57	6.85	4.22	5.07	2.11	3.94	11.14	98.00	45.65	1.72	1.87
PCGVT 46	11.69	2.01	4.91	21.47	5.00	5.84	4.00	1.35	4.02	1.20	3.69	6.89	4.12	4.89	2.24	3.81	11.33	98.46	47.10	1.78	1.97
PCGVT 47	11.41	2.00	5.00	21.51	5.37	5.67	4.07	1.38	4.06	1.24	3.99	6.69	4.09	5.28	2.29	3.69	11.41	99.15	50.30	1.95	1.91
PCGVT 48	11.06	2.04	4.09	21.51	4.90	5.81	3.95	1.39	4.19	1.17	3.95	6.91	4.36	4.92	2.04	4.00	11.35	97.34	44.95	1.88	1.84
PCGVT 49	11.23	2.02	4.00	21.61	4.79	5.69	3.87	1.34	3.90	1.19	3.94	6.92	4.00	4.86	1.94	3.89	11.20	96.39	45.05	1.87	1.88
PCGVT 50	11.03	2.00	4.27	21.49	4.74	5.81	3.79	1.29	4.03	1.21	3.87	6.88	3.94	4.78	2.01	3.90	11.61	96.45	45.35	1.79	1.85
PCGVT 51	11.35	2.02	4.03	21.39	4.69	5.79	3.90	1.39	3.93	1.19	3.86	6.97	3.91	4.73	2.04	3.94	11.36	96.47	45.75	1.80	1.86
PCGVT 52	11.42	2.07	4.05	21.75	4.59	5.79	3.98	1.37	4.06	1.21	3.78	6.88	4.02	5.04	2.02	3.82	11.23	97.08	49.25	1.82	1.90
PCGVT 53	11.05	2.27	4.00	21.41	4.54	5.61	3.84	1.40	4.03	1.13	3.79	6.90	4.09	4.94	2.08	3.95	11.34	96.37	45.05	1.90	1.83
PCGVT 54	11.29	2.34	4.05	21.44	4.49	5.83	4.00	1.40	4.04	1.19	3.82	6.84	4.04	4.95	2.24	4.13	11.33	97.42	42.65	1.82	1.83
PCGVT 55	11.04	2.24	4.05	21.21	4.39	5.84	4.04	1.36	4.08	1.24	3.84	6.89	4.05	4.89	2.29	3.79	11.14	96.38	50.35	1.79	1.80
MEAN	12.02	2.38	4.93	21.44	4.78	5.86	4.13	1.36	4.19	1.26	3.64	6.96	4.23	5.20	2.28	3.80	11.71	100.12	47.28	1.79	1.83
MIN	11.03	1.98	4.00	20.40	4.39	5.31	3.47	1.19	3.90	1.10	3.32	6.49	3.91	4.73	1.94	3.32	11.01	96.37	42.25	1.57	1.76
MAX	12.96	2.92	5.39	22.29	5.37	6.26	4.67	1.48	4.55	1.39	4.01	7.35	4.54	5.66	2.70	4.30	12.31	103.14	53.10	2.33	1.97
SE	±0.059	±0.027	±0.045	±0.046	±0.026	±0.026	±0.029	±0.008	±0.019	±0.007	±0.027	±0.022	±0.018	±0.023	±0.021	±0.027	±0.046	±0.293	±0.204	±0.022	±0.01

(r=0.12). Also, the correlation between O/L ratios and any one of the amino acids was nonsignificant. It was found that T/AT ratios of cultivars ranged from 1.76 to 1.97, indicative of good flavor potential.

References

Basha, S.M.M., Cherry,J.P., and Young, C.T. 1976. Changes in free amino acids, carbohydrates, and proteins of maturing seeds from various peanut (Arachis hypogaea L.) Cereal Chemistry 53:586-597.

Basha, S.M.M., Cherry,J.P., and Young, C.T. 1980. Free and total amino acid composition of maturing seed from six peanut (Arachis hypogaea L.) cultivars. Peanut Science 7:32-37.

Basha, S.M.M., and Pancholy, S.K. 1982. Composition and characteristics of basic proteins from peanut (Arachis hypogaea L.) seed. Journal of Agricultural and Food Chemistry 30:1176-1179.

Johnson, B.R., Mozingo, R.W., and Young, C.T. 1976. Evaluation of the Arginine Maturity Index (AMI) method of maturity estimation for Virginia type peanuts. Peanut Science 3:32-36.

Moore, S., Stein , W.H. 1963. Chromatographic determination of amino acids by the use of automatic recording equipment. Pages 819-831 in Methods in Enzymology Vol. VI (Colowick, S.P., and Kaplan, N.O. eds.), New York, Academic Press.

Oupadissakoon, C., and Young, C.T. 1984. Modelling of roasted peanut flavor for some Virginia-type peanuts from amino acid and sugar contents. Journal of Food Science 49:52-58.

SECTION III. OIL QUALITY AND FATTY ACID COMPOSITION

III. OIL QUALITY AND FATTY ACID COMPOSITION

1.0 INTRODUCTION

Groundnut oil is a high quality vegetable oil and a large percentage of world groundnut production is utilized for oil extraction. Groundnut oil is composed of mixed glycerides of approximately 80% unsaturated and 20% saturated fatty acids. The fatty acid composition varies with the cultivar and cultural conditions under which it is grown. Since the oil is derived from a vegetable source, the fatty acids are composed mainly of even carbon numbers from C_{16} to C_{24}. The major fatty acids, number of carbon atoms and the number of unsaturated double bonds are as follows : palmitic (hexadecanoic, 16:0), stearic (octadecanoic, 18:0), oleic (cis-9-octadecenoic, 18:1), linoleic (Cis 9, cis 12-octadecadienoic, 18:2) arachidic (eicosanoic, 20:0), cis 11-eicosenoic (20:1), behenic (docosanoic, 22:0) and lignoceric (tetracosanoic, 24:0). In addition, there are certain fats that are not extracted by n-hexane and are called as 'invisible fats' (Achaya 1986). The tightly bound invisible fats are extractable with solvents like chloroform-methanol and water-saturated butanol.

2.0 MATERIALS AND METHODS

2.1 Materials

The seed material for our study consisted of five groundnut cultivars ICGS 1, ICGS 5, ICGS 11, ICGS 21, and ICGS 44, along with two controls Kadiri 3, and J 11. These cultivars were grown

at ICRISAT Center, during the 1985/86 postrainy and 1988 rainy seasons as described earlier.

2.2 Methods

2.2.1 Extraction of free and bound lipid fractions

The groundnut samples were extracted with a nonpolar solvent, hexane and the meal were re-extracted sequentially with hexane, followed by chloroform and methanol (2:1 v/v), and finally with water-saturated butanol. The percentage of the extractable lipids in each of the solvents was determined and the extracted lipids were analyzed for their fatty acid composition.

2.2.2 Preparation of fatty acid methyl esters

The fatty acid methyl esters (FAME) of triglycerides were prepared according to the method of Metcalfe (1966) and Quality Methods, (1984).

The lipid fraction comprising about 50 mg obtained after extraction with solvent, was treated with 1.3 ml of 0.5 N NaOH in methanol and heated in a boiling water bath for 5 min. The contents were cooled, and 2 ml of boron trifluoride (BF_3) in methanol was added, and heated again in the boiling water bath for 5 min and cooled. To this mixture, 2 ml of a saturated solution of sodium chloride was added, and the contents were shaken on a tube rotator for 10 min. Then 2 ml of petroleum ether (boiling range 60-80°C) was added, and again the contents were shaken on a tube rotator for 10 min and centrifuged for 5 min in a table-top centrifuge. The petroleum ether layer was

transferred into a vial and flushed with nitrogen and stored in the refrigerator for further analysis.

2.2.3 Analysis of the fatty acid methyl esters in a gas chromatograph

Fatty acid methyl esters of all fractions were analyzed in a Shimadzu 9A model gas chromatograph (GC) equipped with a flame-ionization detector (FID), a temperature programmable oven and a CR 3A integrator. The fatty acid methyl esters were separated on a glass column (6 feet long with 3 mm inner diameter) packed with Alltech CS-10 chromosorb W-AW (80-100 mesh). The carrier gas (Helium) flow rate was 50 ml/min. After ignition of the flame ionization detector, the hydrogen flow was maintained at 0.6 kg/cm^2 and air flow at 0.5 kg/cm^2. The injection port temperature/detector temperatures were 260°C. The column temperature was held at 190°C for 4 min initially, followed by programming at the rate of increase of 10°C/min to a final temperature of 250°C and held at 250°C for 2 min. About 1-2 ul of sample was injected for analysis.

2.2.4 Identification of peaks

The individual peaks of the sample were identified by matching with the retention times of the peaks of the reference standard (Nucheck 21A groundnut fatty acid composition). The FAMEs eluted in the following order: palmitic (16:0), stearic (18:0), oleic (18:1), linoleic (18:2), arachidic (20:0), eicosenoic (20:1), behenic (22:0) and lignoceric (24:0). FAMEs were quantified using corrected area normalization method.

2.2.5 Oil quality

2.2.5.1 Iodine value (IV)

Iodine value is a measure of the unsaturation of fats and oils and is expressed as the number of centigrams of iodine absorbed per gram of sample. Iodine value of the groundnut cultivars was determined according to the method of AOCS[a] (1980).

2.2.5.2 Saponification value

Saponification value is the amount of alkali necessary to saponify a definite quantity of the fat and is expressed as the number of milligrams of potassium hydroxide required to saponify 1 g of fat. Saponification value was determined according to the method of AOCS[b] (1980).

2.2.5.3 Acid value

Acid value is a measure of the amount of free fatty acids in the oil or fat. It is defined as the number of milligrams of potassium hydroxide required to neutralize the free fatty acids in 1 gram of oil or fat. Acid value was determined according to the method of AOCS[c] (1980).

2.2.5.4 Peroxide value

Peroxide value determines the initial and primary products of lipid oxidation, in terms of milli-equivalents of peroxide per 1000 g of sample, which oxidize potassium iodide under the test conditions. Peroxide value was determined according to the method of AOCS[d] (1980).

2.2.5.5 Color

The absorbance of color of oil obtained from groundnut cultivars was measured at 420, 450 and 453 nms using Beckman DBGT and Shimadzu spectrophotometers.

3.0 RESULTS AND DISCUSSION

3.1 Solvent extractable lipid fractions

Results of analysis of groundnut cultivars obtained from the 1985/86 postrainy season showed (Table 15) that the mean value of bound lipids obtained from the extraction with chloroform-methanol was 1.6% and water-saturated butanol was 2.6%. Even after extraction with hexane, about 0.2% of the lipids were retained and could only be reextracted after grinding the residue with hexane.

Table 16 shows the results of the lipid content of the groundnut cultivars grown during the 1988 rainy season. The lipid content of hexane extract, hexane re-extract and chloroform-methanol extract of this season were higher than those of the 1985/86 postrainy season. The water saturated butanol extract showed a lipid content of 1.8% as compared to 2.6% in the 1985/86 crop.

3.2 Oil quality studies and fatty acid composition

The fatty acid composition of hexane, hexane re-extract, chloroform-methanol and water saturated butanol extracts obtained from the cultivars grown in the postrainy season 1985/86 are presented in the Tables 17-20. Similar results obtained from the extracts made from cultivars grown in 1988 rainy season are given

Table 15. Solvent extractable lipid fractions in groundnut cultivars, postrainy season 1985/86, ICRISAT Center[1]

Cultivar	Hexane extract	Hexane re-extract	Chloroform-methanol extract	Water-saturated butanol extract
	(%)			
ICGS 1	47.3±0.03	0.2±0.03	1.6±0.10	2.9±0.01
ICGS 5	47.0±0.01	0.2±0.01	1.5±0.06	2.9±0.06
ICGS 11	46.9±0.02	0.2±0.01	1.5±0.12	2.8±0.23
ICGS 44	48.1±0.01	0.2±0.01	1.4±0.13	2.1±0.02
Control				
Kadiri 3	44.0±0.04	0.2±0.01	1.6±0.09	2.2±0.07
Mean[2]	46.6	0.2	1.6	2.6
SE[2]	±0.70	±0.01	±0.06	±0.18

1. Means and SE of three replicates
2. Means and SE of five cultivars

Table 16. Solvent extractable lipid fractions in groundnut cultivars, rainy season 1988, ICRISAT Center[1]

Cultivar	Hexane extract	Hexane re-extract	Chloroform-methanol extract	Water-saturated butanol extract
	(%)			
ICGS 1	49.3±0.09	0.4±0.05	1.6±0.02	1.7±0.01
ICGS 5	49.3±0.15	0.4±0.02	1.7±0.07	1.7±0.06
ICGS 11	48.9±0.11	0.4±0.06	1.7±0.05	1.8±0.04
ICGS 21	50.7±0.03	0.3±0.03	1.7±0.02	1.9±0.04
ICGS 44	49.5±0.05	0.4±0.04	1.8±0.01	1.8±0.04
Controls				
Kadiri 3	48.0±0.04	0.3±0.08	2.0±0.08	1.9±0.03
J 11	48.4±0.20	0.2±0.05	1.9±0.01	1.7±0.08
Mean[2]	49.2	0.4	1.8	1.8
SE[2]	±0.33	±0.03	±0.05	±0.04

1. Means and SE of three replicates
2. Means and SE of seven cultivars

Table 17. Fatty acid composition of hexane extracts of groundnut cultivars, postrainy season 1985/86, ICRISAT Center[1]

Fatty acid (%)	ICGS 1	ICGS 5	ICGS 11	ICGS 21	ICGS 44	Kadiri 3	Control Mean[2]	Control SE[2]
Palmitic	12.1±0.07	11.9±0.04	12.1±0.02	11.3±0.01	11.9±0.04	12.1±0.05	11.9	±0.13
Stearic	2.3±0.00	2.1±0.01	2.3±0.0*	2.8±0.01	2.7±0.00	2.9±0.00	2.5	±0.13
Oleic	36.7±0.03	37.2±0.01	36.8±0.04	42.9±0.07	38.9±0.05	38.9±0.02	38.6	±0.95
Linoleic	40.5±0.01	40.5±0.0*	40.6±0.05	35.1±0.04	38.4±0.04	38.0±0.01	38.9	±0.88
Arachidic	1.4±0.0*	1.3±0.02	1.4±0.02	1.4±0.01	1.5±0.00	1.5±0.0*	1.4	±0.03
Eicosenoic	1.4±0.02	1.4±0.02	1.4±0.02	1.3±0.00	1.4±0.00	1.4±0.0*	1.4	±0.02
Behenic	3.2±0.00	3.1±0.01	3.0±0.0*	2.9±0.0*	3.0±0.01	2.8±0.02	3.0	±0.04
Lignoceric	1.8±0.00	1.7±0.02	1.8±0.01	1.5±0.02	1.7±0.00	1.8±0.02	1.7	±0.04
O/L ratio	0.91±0.00	0.92±0.00[illegible]	0.91±0.01[illegible]	1.23±0.00[illegible]	1.01±0.00	1.03±0.00	1.00	±0.050

1. Means and SE of three replicates
2. Means and SE of six cultivars

Table 18. Fatty acid composition of hexane re-extracts of groundnut cultivars, postrainy season 1985/86, ICRISAT Center[1]

Fatty acid (%)	ICGS 1	ICGS 5	ICGS 11	ICGS 21	ICGS 44	Kadiri 3	Control Mean[2]	Control SE[2]
Caprylic	6 1±0 03	6 2±0 59	6 9±1 30	4 2±0 00	6 3±0 44	6 4±0 23	5.7±0.37	
·ic	5 8±0 17	6.1±0 41	6 9±0 85	6 9±0 00	7 5±0 21	7.5±0.55	6 1±0.68	
·ic	2 2±0 13	2 3±0 27	2 1±0 17	1 7±0 00	2 7±0 29	2 6±0.28	2.3±0.15	
Myristic	27 1±2 57	23 8±1 11	27 0±0 52	18 9±0 00	21 1±0 78	25 6±1 14	23 2±1.22	
Myristoleic	3 2±0 02	3 7±0 55	3 6±0 08	1 9±0 00	3 9±0 70	4 8±0 62	3 5±0 38	
Palmitic	8 1±1 02	8 5±0 52	8 6±0 90	9 1±0 00	8 4±0 88	7 3±0 70	8 4±0 25	
Palmitoleic	1 1±0 10	1 1±0 11	1 2±0 00	1 0±0 00	1 4±0 22	1 3±0 01	1.2±0 06	
Stearic	11 4±0 75	11 2±1 53	10 0±0 29	9 2±0 00	12 8±0 43	12 6±0 44	11.2±0 58	
Oleic	13 7±1 23	15 3±1 40	18 0±2 46	23 7±0 00	14 7±0 81	13 3±0 80	16 4±1.60	
Linoleic	15 3±1 30	15 9±1 70	19 0±1 86	19 3±0 00	14 7±1 38	12 6±0 98	16 1±1.05	
Arachidic	0 6±0 04	0 8±0 12	0 8±0 16	0 8±0 00	0 8±0 05	0 8±0 05	0 8±0 04	
Eicosenoic	0 5±0 03	0 5±0 07	0 8±0 00	0 7±0 00	0 6±0 04	0 5±0 05	0 6±0 05	
Behenic	1 2±0 06	1 2±0 20	1 2±0 22	1 8±0 00	1 3±0 05	1 2±0 07	1 3±0 10	
Lignoceric	0 9±0 17	1 0±0 04	1 0±0 24	1 1±0 00	1 1±0 14	0 9±0 19	1 0±0 07	
O/L ratio	0 90±0 00	0 97±0 01	0 95±0 04	1 23±0 00	1 01±0 04	1 06±0 02	1 02±0 04	

1. Means and SE of three replicates
2. Means and SE of six cultivars

Table 19. Fatty acid composition of chloroform-methanol extracts of groundnut cultivars, postrainy season 1985/86, ICRISAT Center[1]

Fatty acid (%)	ICGS 1	ICGS 5	ICGS 11	ICGS 21	ICGS 44	Kadiri 3	Control Mean[2]	Control SE[2]
Myristic (14:0)	0.1±0.01	0.1±0.02	0.1±0.04	0.1±0.02	0.1±0.01	0.2±0.02	0.1±0.01	
Myristoleic (14:1)	0.3±0.02	0.3±0.04	0.2±0.03	0.3±0.04	0.2±0.14	0.2±0.07	0.2±0.02	
Palmitic (16:0)	24.3±0.04	24.4±0.12	24.4±0.13	22.8±0.07	23.5±0.14	24.9±0.07	24.0±0.31	
Stearic (18:0)	3.7±0.02	3.2±0.03	3.5±0.02	3.6±0.04	3.4±0.01	3.2±0.07	3.4±0.08	
Oleic (18:1)	29.9±0.12	32.9±0.10	31.8±0.05	36.7±0.12	33.3±0.02	33.8±0.02	33.1±0.92	
Linoleic (18:2)	38.2±0.34	36.1±0.06	37.0±0.31	33.5±0.27	37.0±0.25	35.4±0.11	36.2±0.66	
Arachidic (20:0)	0.03±0.01	0.03±0.00	0.04±0.01	0.03±0.02	0.03±0.00	0.02±0.00	0.03±0.02	
Eicosenoic (20:1)	0.4± 0.02	0.4±0.01	0.4±0.01	0.4±0.01	0.4±0.01	0.3±0.01	0.4±0.02	
Behenic (22:0)	0.7±0.05	0.6±0.02	0.6±0.04	0.6±0.04	0.6±0.01	0.5±0.03	0.6±0.03	
Lignoceric (24:0)	1.7±0.18	1.5±0.04	1.4±0.12	1.4±0.07	1.2±0.01	1.0±0.06	1.4±0.10	
O/L ratio	0.78±0.009	0.91±0.003	0.86±0.006	1.10±0.009	0.91±0.005	0.96±0.003	0.92±0.048	

1. Means and SE of three replicates
2. Means and SE of six cultivars

Table 20. Fatty acid composition of water saturated butanol extracts of groundnut cultivars, postrainy season 1985/86, ICRISAT Center[1]

Fatty acid (%)	ICGS 1	ICGS 5	ICGS 11	ICGS 21	ICGS 44	Control		
						Kadiri 3	Mean[2]	SE[2]
Lauric (12:0)	1.8±0.64	15.2±0.27	0.9±0.19	2.5±0.00	ND	2.9±0.00	1.9±0.35	
Myristic (14:0)	1.0±0.34	0.9±0.26	0.8±0.26	0.7±0.33	1.2±0.14	0.8±0.13	0.9±0.06	
Myristoleic (14:1)	ND	1.4±0.48	1.1±0.57	0.6±0.18	0.7±0.38	0.6±0.31	0.9±0.16	
Palmitic (16:0)	22.7±0.27	22.6±0.73	22.3±0.20	21.1±0.42	20.5±0.87	22.0±1.78	21.9±0.36	
Palmitoleic (16:1)	1.1±0.00	ND	ND	ND	1.0±0.32	0.6±0.00	0.9±0.13	
Stearic (18:0)	4.9±0.05	5.4±0.22	5.0±0.28	5.0±0.14	4.3±0.26	5.2±1.04	5.0±0.15	
Oleic (18:1)	31.3±0.95	36.9±1.20	33.5±0.54	40.2±0.76	32.7±1.84	33.0±0.29	34.3±1.28	
Linoleic (18:2)	30.2±1.88	29.6±0.72	31.3±1.33	27.4±1.93	29.9±1.79	30.0±0.39	29.7±0.52	
Behenic (22:0)	1.3±0.05	1.2±0.33	1.2±0.15	1.2±0.08	1.0±0.05	1.8±0.08	1.3±0.12	
Lignoceric (24:0)	1.1±0.18	0.9±0.09	1.3±0.08	1.1±0.20	1.1±0.05	1.1±0.00	1.1±0.05	
O/L ratio	1.04±0.030	1.18±0.026	1.08±0.028	1.48±0.084	1.10±0.005	1.11±0.010	1.17±0.066	

1. Means and SE of three replicates ND - not detected
2. Mean and SE of six cultivars

Table 21. Fatty acid composition of hexane extracts of groundnut cultivars, rainy season 1988, ICRISAT Center[1]

Fatty acid (%)	ICGS 1	ICGS 5	ICGS 11	ICGS 21	ICGS 44	Controls: Kadiri 3	Controls: J 11	Controls: Mean[2]	Controls: SE[2]
Palmitic (16:0)	12.8±0.01	12.5±0.02	12.5±0.04	11.6±0.08	12.5±0.10	14.2±0.03	12.4±0.04	12.6	±0.30
Stearic (18:0)	2.2±0.01	2.2±0.01	2.1±0.01	2.7±0.01	2.2±0.01	2.3±0.00	5.6±0.02	2.8	±0.48
Oleic (18:1)	37.1±0.05	37.2±0.05	37.2±0.04	44.7±0.09	37.5±0.08	37.1±0.04	40.4±0.06	38.8	±1.09
Linoleic (18:2)	39.0±0.01	39.2±0.14	39.4±0.03	33.7±0.04	39.0±0.01	38.7±0.02	32.5±0.02	37.3	±1.11
Arachidic (20:0)	1.4±0.01	1.4±0.01	1.4±0.01	1.4±0.01	1.4±0.00	1.4±0.00	2.4±0.01	1.5	±0.16
Eicosenoic (20:1)	1.4±0.01	1.4±0.01	1.4±0.01	1.3±0.01	1.4±0.00	1.4±0.01	0.9±0.00	1.3	±0.09
Behenic (22:0)	3.2±0.01	3.3±0.02	3.2±0.02	2.9±0.01	3.3±0.01	3.2±0.01	4.0±0.01	3.3	±0.12
Lignoceric (24:0)	1.8±0.03	1.8±0.02	1.7±0.02	1.3±0.01	1.8±0.02	1.7±0.01	1.4±0.00	1.6	±0.08
O/L ratio	0.96±0.00	0.95±0.003	0.95±0.00	1.35±0.003	0.96±0.003	0.96±0.000	1.25±0.003	1.06	±0.064

1. Means and SE of three replicates
2. Means and SE of seven cultivars

in Tables 21-24. ICGS 21 exhibited the highest O/L ratio in all the four extracts of groundnut cultivars grown during the two seasons. The fatty acid composition of the hexane re-extract, contained in addition to the normal fatty acids of groundnut, caprylic, capric, lauric, myristic, myristoleic and palmitoleic acid. Comparing the two seasons' data, the content of myristic acid was noticeably higher in the 1985/86 postrainy season than in the 1988 rainy season.

The chloroform-methanol extract contained lauric, myristic and myristoleic acids in addition to the normal fatty acids of groundnut. The bound fatty acids of the water-saturated butanol extract were similar to chloroform-methanol extract, except for the presence of an additional fatty acid, palmitoleic acid. An additional feature of the data obtained with 1988 samples was the presence of capric acid in the water saturated butanol extract of all samples, and its absence in the 1985/86 samples. The bound lipids were released only on extraction with sample polar solvents like chloroform-methanol mixture and water-saturated butanol. It can be concluded that the fatty acids lauric, myristic, myristoleic and palmitoleic are tightly bound, though some of them appeared only in the hexane re-extract. They are also present in the water saturated-butanol extract. The water saturated butanol is reported to destroy the cell structure and release lipid constituents bound to the cell. Similar to the free lipid fraction, linoleic, oleic, and palmitic acids were the major fatty acids in the bound lipids' fraction as well. It can

Table 22. Fatty acid composition of hexane re-extracts of groundnut cultivars relay season 1988, [illegible] Center

Fatty acid (%)	ICGS 1	ICGS 5	ICGS 11	ICGS 21	ICGS 44	Controls: Kaffir 1	Controls: J 11	Controls: Mean[2] SE[2]
Caprylic (8:0)	4.9±0.79	2.1±0.60	5.2±2.09	1.5±0.30	1.5±0.52	ND	ND	3.0±0.83
Capric (10:0)	2.5±0.15	1.6±0.23	2.3±0.17	1.7±0.47	1.8±0.15	0.4±0.14	0.4±0.09	1.5±0.32
Lauric (12:0)	8.4±0.71	4.3±0.86	6.1±0.75	4.2±0.90	6.0±0.00	2.1±0.36	2.4±0.47	4.8±0.83
Myristic (14:0)	9.5±0.69	6.4±0.91	5.9±0.76	3.3±1.00	2.8±0.57	1.8±0.22	1.9±0.27	4.2±1.03
Myristoleic (14:1)	4.5±0.32	2.7±0.38	3.9±0.13	3.3±0.30	2.9±0.49	1.2±0.15	1.4±0.80	2.8±0.45
Palmitic (16:0)	11.5±0.52	13.5±0.28	13.2±0.53	13.5±0.92	14.5±0.71	16.5±0.58	15.9±0.12	14.1±0.65
Palmitoleic (16:1)	1.0±0.05	0.6±0.15	0.7±0.16	0.7±0.16	1.2±0.12	0.9±0.11	1.1±0.13	0.9±0.09
Stearic (18:0)	4.7±0.21	3.8±0.26	4.3±0.29	4.9±0.38	5.7±0.06	5.3±0.28	7.5±0.54	5.2±0.46
Oleic (18:1)	17.9±1.77	26.5±1.48	20.5±1.43	32.1±1.85	22.1±1.41	30.2±0.39	32.8±0.74	25.7±2.26
Linoleic (18:2)	18.9±2.02	28.1±1.95	22.7±1.58	22.6±0.65	23.0±1.82	30.2±0.82	26.2±1.49	26.5±1.45
Arachidic (20:0)	0.5±0.04	0.7±0.05	0.6±0.08	0.7±0.02	0.5±0.16	1.0±0.06	1.1±0.05	0.7±0.09
Eicosenoic (20:1)	0.4±0.06	0.8±0.09	0.6±0.07	0.6±0.02	0.5±0.13	1.0±0.07	0.4±0.03	0.6±0.07
Behenic (22:0)	1.5±0.14	2.1±0.22	1.3±0.18	1.8±0.06	1.2±0.06	2.2±0.16	1.9±0.17	1.7±0.15
Erucic (22:1)	1.8±0.18	1.3±0.08	1.4±0.06	1.0±0.22	0.6±0.04	0.5±0.02	0.6±0.05	1.0±0.19
Lignoceric (24:0)	0.8±0.09	1.4±0.19	1.1±0.14	1.1±0.07	1.3±0.08	1.7±0.05	1.1±0.13	1.2±0.12
O/L ratio	0.96±0.012	0.88±0.026	0.90±0.005	1.42±0.046	0.97±0.015	1.00±0.020	1.27±0.045	1.06±0.19

1. Means and SE of three replicates
2. Means and SE of seven cultivars
3. It's presence was detected in only one of the 3 replicates; ND - Not detected

Table 23. Fatty acid composition of chloroform-ethanol extracts of groundnut cultivars, rainy season 1988.

ICRISAT Center

Fatty acid (%)	ICGS 1	ICGS 5	ICGS 11	ICGS 21	ICGS 44	Kadiri 3	Controls J 11	Mean[2]	SE[2]
Lauric (12:0)	0.1±0.02	-	0.1±0.04	0.1±0.01	0.1±0.00	0.1±0.01	0.1±0.00	0.1±0.01	
Myristic (14:0)	0.1±0.04	0.1±0.03	0.2±0.02	0.1±0.05	0.2±0.03	0.7±0.61	0.1±0.04	0.2±0.08	
Myristoleic (14:1)	0.04±0.00	0.04±0.01	0.1±0.01	0.1[3]	0.2[3]	0.3[3]	0.1[3]	0.1±0.03	
Palmitic (16:0)	24.5±0.33	25.0±0.25	25.2±0.27	22.0±0.13	25.5±0.50	25.22±0.20	22.0±0.23	24.1±0.59	
Stearic (18:0)	3.1±3.11	3.1±0.04	3.2±0.05	3.7±0.03	3.2±0.08	3.3±0.04	5.4±0.08	3.6±0.31	
Oleic (18:1)	31.9±0.10	32.1±0.14	31.5±0.20	44.2±0.16	31.5±0.09	34.3±0.30	39.0±0.02	34.9±1.86	
Linoleic (18:2)	37.2±0.50	36.1±0.61	36.0±0.73	26.7±0.04	34.9±0.97	31.8±0.94	29.6±0.63	33.1±1.67	
Arachidic (20:0)	Traces	0.1±0.05	0.1±0.06	0.2±0.05	0.2±0.06	0.2±0.08	0.3±0.01	0.2±0.03	
Eicosenoic (20:1)	0.4±0.01	0.4±0.01	0.5±0.01	0.5±0.02	0.5±0.04	0.5±0.01	0.4±0.01	0.5±0.02	
Behenic (22:0)	0.6±0.02	0.7±0.01	0.7±0.02	0.6±0.04	0.7±0.03	0.79±0.10	0.8±0.01	0.7±0.03	
Lignoceric (24:0)	1.7±0.25	2.0±0.20	2.2±0.18	1.4±0.00	2.6±0.36	2.1±0.36	1.61±0.19	1.95±0.15	
O/L ratio	0.86±0.020	0.89±0.015	0.88±0.025	1.66±0.006	0.92±0.026	1.08±0.023	1.32±0.026	1.09±0.114	

1. Means and SE of three replicates
2. Means and SE of seven cultivars
3. It's presence was detected in only one of the 3 replicates

Table 24. Fatty acid composition of water-saturated butanol extracts of groundnut cultivars, rainy season 1988, ICRISAT Center[1]

							Controls	
Fatty acid (%)	ICGS 1	ICGS 5	ICGS 11	ICGS 21	ICGS 44	Kadiri 3	J 11	Mean[2] SE[2]
Capric (10:0)	0.6±0.03	0.7±0.06	0.8±0.04	0.7±0.01	0.6±0.02	1.0±0.04	0.9±0.26	0.8±0.07
Lauric (12:0)	0.6±0.17	0.4±0.02	0.6±0.16	0.4±0.02	0.4±0.01	1.2±0.50	0.7±0.23	0.6±0.11
Myristic (14:0)	0.7±0.22	1.2±0.04	1.0±0.11	1.1	0.9±0.33	1.3	1.2±0.00	1.1±0.08
Myristoleic (14:1)	1.1±0.15	1.1±0.02	ND	1.2	0.8±0.08	ND	ND	1.0±0.07
Palmitic (16:0)	24.3±0.26	24.7±0.48	25.9±0.08	22.3±0.38	25.6±1.08	25.9±0.15	23.9±0.06	24.6±0.53
Stearic (18:0)	4.5±0.07	4.3±0.07	4.8±0.31	5.6±0.17	4.5±0.15	5.4±0.08	8.3±0.67	5.4±0.53
Oleic (18:1)	31.7±0.44	30.4±0.39	31.4±0.35	42.7±0.49	30.3±0.85	33.7±0.07	36.2±0.51	33.8±1.68
Linoleic (18:2)	32.5±0.86	32.0±0.18	31.8±1.08	23.7±0.48	29.9±0.02	28.4±0.67	26.3±0.47	29.2±1.25
Behenic (22:0)	1.1±0.09	0.9±0.02	1.0±0.11	1.0±0.04	1.0±0.04	1.1±0.10	1.1±0.10	1.0±0.03
Lignoceric (24:0)	1.5±0.06	1.5±0.05	1.6±0.16	1.1±0.03	2.1±0.57	1.4±0.04	1.5±0.03	1.5±0.12
O/L ratio	0.98±0.040	0.95±0.005	1.00±0.045	1.81±0.015	1.02±0.020	1.20±0.020	1.38±0.033	1.19±0.047

1. Means and SE of two replicates ND - not detected
2. Means and SE of seven cultivars

also be noted that eicosenoic acid (20:1) and arachidic acids which were present in the three extracts, hexane, hexane re-extract, and chloroform-methanol extract, were absent in the water-saturated butanol extract.

3.3 Evaluation of oil quality

The oil quality of commercial oils can be evaluated using iodine value, Saponification value, acid value, and peroxide value, of which the iodine value is a reflection of the melting point or hardness of fat, as well as a measure of its resistance or susceptibility to oxidation.

Among the seven cultivars grown during the 1985/86 postrainy season, ICGS 1 showed the highest iodine value of 99 (Table 25) and is probably more susceptible to oxidation owing to its high degree of unsaturation. ICGS 21 had the highest amount of saponifiable matter and ICGS 11 showed the presence of a large amount of free fatty acids (acid value 0.87, free fatty acid % = 0.44). The absorbance of extracted oil was recorded at three wavelengths, 420, 450 and 453 nms. ICGS 5 showed the maximum absorbance at 453 nms, (A = 0.442), due to more intense color of the oil (Table 25).

The oil characteristics of the groundnut cultivars grown during the 1988 rainy season are shown in Table 26. The highest iodine value was shown by ICGS 44 (99) and lowest by J 11 (91). The Saponification value was highest in J 11 (185), and among the ICRISAT cultivars ICGS 5, showed a high value of Saponification

Table 25. Oil quality characteristics of groundnut cultivars, postrainy season 1985/86, ICRISAT Center1

Cultivar	Acid value	Free fatty acid (%)2	Saponification value	Iodine value	Absorbance at 420 nm	Absorbance at 453 nm
ICGS 1	0.70±0.007	0.36±0.003	189.1±0.82	98.9±0.07	0.314	0.342
ICGS 5	0.55±0.012	0.28±0.007	184.8±0.18	98.0±0.07	0.394	0.442
ICGS 11	0.87±0.015	0.44±0.009	186.8±1.49	97.1±0.36	0.365	0.379
ICGS 21	0.42±0.007	0.22±0.003	191.3±0.69	94.2±0.20	0.280	0.314
ICGS 44	0.45±0.01	0.23±0.006	187.3±0.32	93.6±0.22	-	0.319
Control						
Kadiri 3	0.57±0.009	0.29±0 003	186.4±0.48	92.5±0.07	-	0.213
Mean[3]	0.59	0.30	187.6	95.7	0.338	0.335
SE[3]	0.069	0.034	0.93	1.07	0.0255	0.031

1. Means and SE of three replicates
2. Free fatty acid expressed as a percent of oleic acid
3. Means of SE of six cultivars

(184). There was not much variation in the content of free fatty acids among the cultivars.

The peroxide values (meq. kg^{-1}) of the groundnut cultivars ranged from 4.4 to 9.4 with a mean of 6.87±0.59. The highest peroxide value was given by ICGS 44 (9.4, Table 26). The maximum acceptable level of peroxides value is 10 (meq. kg^{-1}) as indicated by the Codex Alimentarius (Narasimhan et al. 1986) for raw groundnut oil and it is less than one for freshly refined oil.

From the data obtained on the samples from the two seasons harvest, it can be seen that the acid value and Saponification values were higher in the cultivars grown during the 1985/86 postrainy season. The intensity of the oil color was lower among the 1988 rainy cultivars, than the 1985/86 postrainy cultivars. ICGS 44 showed the highest iodine value, that is a high degree of unsaturation, during the 1988 season, while ICGS 1 had the highest iodine value among the cultivars grown during the 1985/86 post rainy season.

It has been shown that oils obtained from different groundnut cultivars differ considerably in their tendency to develop oxidative rancidity. This is related, in part, to the degree of unsaturation of the oil (Fore, 1953). So the iodine value, peroxide value, and acid value of oil are important factors that determine the oxidative stability of the oil.

Table 26. Oil quality characteristics of groundnut cultivars, rainy season 1988, ICRISAT Center[1]

Cultivar	Acid value		Free fatty acid (%)[2]		Saponification value		Iodine value		Peroxide value (meqs/kg)	Absorbance at 420 nm	Absorbance at 450 nm
	Mean	SE	Mean	SE	Mean	SE	Mean	SE			
ICGS 1	0.10	±0.006	0.05	±0.003	182.8	±0.20	96.8	±0.31	7.9	±0.01	0.158	0.153
ICGS 5	0.15	±0.009	0.08	±0.004	183.9	±0.39	97.5	±0.22	6.6	±0.06	0.114	0.126
ICGS 11	0.11	±0.006	0.06	±0.003	175.4	±0.23	95.5	±1.14	6.5	±0.03	0.111	0.126
ICGS 21	0.14	±0.000	0.07	±0.000	180.9	±0.18	93.2	±0.68	7.3	±0.01	0.097	0.126
ICGS 44	0.15	±0.013	0.08	±0.007	183.4	±0.25	98.9	±0.71	9.4	±0.01	0.268	0.097
Controls												
Kadiri 3	0.14	±0.000	0.07	±0.00	172.5	±0.10	91.4	±0.29	6.1	±0.05	0.080	0.087
J 11	0.14	±0.000	0.07	±0.004	185.0	±0.47	90.8	±0.07	4.4	±0.00	0.258	0.229
Mean[3]	0.13	±0.017	0.07	±0.004	180.6	±1.80	94.9	±1.19	6.9	±0.59	0.155	±0.0293 0.155 ±0.0300

1. Means and SE of three replicates
2. Free fatty acid expressed as a percent of oleic acid
3. Means and SE of seven cultivars

References

Achaya, K.T. 1986. Invisible fats revisited. Proceedings of the Nutrition Society of India 32:1-17.

Metcalfe, L.D., Schmidt, Z.A., and Pelkar, J.R. 1966. Rapid preparation of fatty acid methyl esters from lipids for gas chromatographic analysis. Analytical Chemistry 38:514-515.

Quality Methods 1984. American Peanut Research and Education Society (Young, C.T. Ed.), July 1984. American Peanut Research and Education Society 376, Ag Hall, Oklahoma State University, Stilwater, OK 74078, USA.

Pore, S.P., Morris, N.J., Mack, C.H., Freeman, A.F., and Bickford, W.G. 1953. Factors affecting the stability of crude oils of 16 varieties of peanuts. Journal of American Oil Chemists' Society 30:298.

Official and tentative methods of the American Oil Chemists' Society, 1980. Third edition (cd 125[a], cd 3-25[b], cd-3a-53[c], cd8-53[d]). American Oil Chemists' Society, 508 South Sixth Street, Champaign, Illinois 61820.

Narasimhan, S., Raghuveer, K.G., Arumugham, C., Bhat, K.K., and Sen, D.P. 1986. Oxidative rancidity in groundnut oil - Evaluation by sensory and chemical indices and their correlation. Journal of Food Science and Technology 23:273-277.

SECTION IV. EFFECT OF STORAGE ON OIL QUALITY

IV. EFFECT OF STORAGE ON OIL QUALITY

1.0 INTRODUCTION

The effect of storage on biochemical composition of groundnut seed has been studied (Ramamoorthy and Karivaratharaju 1986). Groundnut oil is composed of mixed triglycerides with a major portion of unsaturated fatty acids, mainly oleic and linoleic acids. Temperature, moisture, and oxygen are the three major environmental factors that influence the stability of fatty acid composition and oil quality during storage.

The oxidative rancidity of groundnut oil on storage, and its effects on the sensory parameters of odor and flavor are important (Narasimhan et al 1985). The tendency to develop oxidative rancidity is related partly to linoleic acid (Fore et al. 1953). Oil quality studies include measurement of parameters like iodine value, Saponification value, peroxide value and oleic/linoleic acid (O/L) ratio. The stability of any oil is reflected upon by it's O/L ratio, which in turn is related to the time, temperature and mode of storage. We investigated the effect of storage at different temperatures on groundnut oils having low, medium and high O/L ratios.

2.0 MATERIALS AND METHODS

2.1 Materials

Oil samples were extracted from the groundnut cultivars belonging to the US confectionery trial and were analyzed for their fatty acid composition in our laboratory. As the quantity

of oil extracted was less, the oil samples were pooled and divided into three categories based on their O/L ratios and O/L ratio was again determined on the pooled samples. They were grouped as follows:

		Category
I	oil samples with O/L ratio of about 1.1	Low
II	oil samples with O/L ratio of about 1.7	Medium
III	oil samples with O/L ratio of about 2.3	High

These samples were stored for a period of seven months in three different environments. The temperature range during the 7 month period was 25.7 to 34.8^{o}C, at location 1 (animal house); 26.4 to 34.3^{o}C at location 2 (food quality evaluation room); and 6.0 to 6.4^{o}C at location 3 (cold room).

A small quantity of oil sample was collected from each of the samples kept at various locations every month and its fatty acid composition and O/L ratios were determined using the gas chromatograph as described earlier.

3.0 RESULTS AND DISCUSSION

Mozingo and Steele (1982) studied the fatty acid composition, iodine values and O/L ratio of different groundnut cultivars and attributed the stability of oils to the linoleic acid content and O/L ratio.

A lower O/L ratio indicates a less stable oil. O/L ratio should preferably be equal to or greater than 1.6 for a stable

oil. Groundnut cultivars having high O/L ratio, high oil content, and better yields would be most desirable. The changes in the O/L ratio of oil due to storage under different environmental conditions are given in Table 27.

I. Oil with low O/L ratio (1.17)

(i) Animal house : The O/L ratio changed from 1.17 to 1.19 in the 3rd month and increased to 1.20 during the seventh month of storage.

(ii) Food quality evaluation room : There was a significant increase from 1.17 to 1.26 during the 2nd month of storage, and reached a maximum of 1.28 by the seventh month.

(iii) Cold room : There was no significant variation during the seven months of storage.

II. Oil with medium O/L ratio (1.66)

(i) Animal house : The O/L ratio increased from 1.66 to 1.70 in the 1st month. It was 1.72 in the second month and 1.73 by the seventh month of storage.

(ii) Food quality evaluation room : There was an initial increase in the O/L ratio during the 1st month, then a fall in the O/L ratio was noticed from 1.70 to 1.56 in the 2nd month of storage, with not much variation thereafter.

(iii) Cold room : There was an initial increase in the O/L ratio in the first month from 1.66 to 1.71, with no significant changes thereafter.

Table 27. Effect of storage on oil samples having low, medium, and high O/L ratios[1]

Storage period (months)	Mean temperature °C	Animal house I	Animal house II	Animal house III	Mean temperature °C	Food quality evaluation room I	Food quality evaluation room II	Food quality evaluation room III	Mean temperature °C	Cold room I	Cold room II	Cold room III
Control (Initial)		1.17^{c}	1.66^{c}	2.28^{c}		1.17^{c}	1.66^{b}	2.28^{d}		1.17^{a}	1.66^{d}	2.28^{e}
One		$1.17^{b,c}$	$1.70^{a,b}$	$2.38^{a,b}$		1.17^{c}	1.70^{a}	2.34^{b}		1.17^{a}	1.71^{a}	2.35^{b}
Two	25.7	$1.18^{b,c}$	$1.72^{a,b}$	$2.37^{a,b}$	28.0	1.26^{b}	1.56^{e}	2.40^{a}	6.4	1.18^{a}	$1.69^{b,c}$	2.38^{a}
Three	27.4	$1.19^{a,b}$	$1.72^{a,b}$	2.40^{a}	26.4	$1.27^{a,b}$	$1.58^{c,d}$	2.40^{a}	6.3	1.18^{a}	1.71^{a}	2.40^{a}
Four	30.0	1.18^{b}	$1.72^{a,b}$	$2.39^{a,b}$	28.2	$1.27^{a,b}$	1.58^{c}	2.38^{a}	6.0	1.18^{a}	$1.71^{a,b}$	2.38^{a}
Five	33.4	$1.19^{a,b}$	$1.70^{a,b}$	2.33^{b}	33.7	$1.27^{a,b}$	1.56^{e}	2.33^{b}	6.0	1.17^{a}	1.68^{c}	$2.32^{c,d}$
Six	34.8	$1.19^{a,b}$	1.69^{b}	$2.35^{a,b}$	34.3	$1.27^{a,b}$	$1.56^{d,e}$	$2.30^{c,d}$	6.0	1.17^{a}	1.68^{c}	2.30^{d}
Seven	30.5	1.20^{a}	1.73^{a}	$2.38^{a,b}$	28.8	1.28^{a}	$1.57^{c,d,e}$	$2.33^{b,c}$	6.2	1.17^{a}	$1.69^{a,b,c}$	$2.33^{b,c}$

Values with the same superscript do not differ significantly from each other

1. Means of three replicates

I - Low O/L ratio, II - Medium O/L ratio III - High O/L ratio

III. Oil with high O/L ratio (2.28)

(i) Animal house : The O/L ratio changed from 2.28 to 2.38 during the 1st month with no significant difference during the later months of storage.

(ii) Food quality evaluation room : Though there was an increase in the O/L ratio during the first three months, the values decreased comparatively during the last three months of storage.

(iii) Cold room : There was an increase in the O/L ratio during the first four months, and the values decreased comparatively during the last four months of storage.

The two significant changes noticed during our study were in the oil samples stored in the food quality evaluation room. During the second and third months of storage, an increase in the O/L ratio in the I category and a significant drop in the O/L ratio of the II category of oil samples were observed.

Results obtained from this study are preliminary as pooled oil samples from several cultivars were used. The storage studies conducted with replicated cultivars having a range in their O/L ratios would give a better understanding of the variation in the O/L ratio or oil quality of groundnut oil, as affected by the changes in temperature, environment, and storage time.

Refe:

Fore, S.P., Morris, N.J., Mack, C.H., Freeman, A.F., and Bickford, W.G. 1953. Factors affecting the stability of crude oils of 16 varieties of peanuts. Journal of American Oil Chemists' Society 30:298-301.

Mozingo, R.W., and Steele, J.L. 1982. Fatty acid composition of peanut genotypes in the Virginia - Carolina production area. Proceedings of American Peanut Research and Education Society 14:29-39.

Narasimhan, S., Raghuveer, K.G., Arumugham, C., Bhat, K.K., and Sen, D.P. 1986. Oxidative rancidity in groundnut oil - Evaluation by sensory and chemical indices and their correlation. Journal of Food Science 23:273-277.

Ramamoorthy, K., and Karivartaraju, T.V. 1986. Storability and biochemical composition of groundnut seed as influenced by packaging and seed treatment. Indian Agriculturist 30(2):100-106.

SECTION V. FATTY ACID COMPOSITION OF ICHTHYAL MARINE OILS AND OTHER COMMON [illegible] OILS

V. FATTY ACID COMPOSITION OF ICRISAT MANDATE CROPS AND OTHER COMMON VEGETABLE OILS

1.0 INTRODUCTION

The fatty acid composition varies with the food material as lipids are the common constituents in most of the foods. The fatty acids present in the ICRISAT mandate crops, sorghum, pearl millet, chickpea, pigeonpea, and groundnut are reported to be rich in palmitic, oleic and linoleic acids.

The consumption of vegetable oils in the form of salad oil or cooking oil has increased dramatically in the recent years. Oils and fats are important food ingredients and are consumed for their nutritional and organoleptic properties. A variety of edible vegetable oils are available and the consumption of a particular oil is dictated more by traditional food habits, availability, and cost than the nutritional quality of the oil. Now that increasing attention is being given to the involvement of lipids in the diseases of circulatory and nervous system, more of unsaturated vegetable oils are being consumed.

Unfortunately, there is no ideal oil or fat and generally each available oil suffers from one drawback or the other. Groundnut oil, for example, is the most important edible oil and accounts for nearly 60% of the total indigenous edible oil supply in India. It is reported to be atherogenic to experimental animals, like rabbits, rats, and monkeys (Kim and Kritchevsky, 1983).

Soybean oil, which dominates the world vegetable market differs from other oils in its linolenic acid content (5-13%), which gives it a "green beany" flavor. This can be removed by conventional refining, bleaching and deodorization methods of oil processing, but the flavor returns on storage, due to auto-oxidation of the linolenic acid.

Mustard oil is the popular edible oil in the North-Eastern parts of India. This oil contains a high percentage of the C-22 unsaturated fatty acid, docosenoic (erucic) acid, which is deleterious to health causing cardiac lipidosis (Abdellatif and Vles, 1970).

Coconut oil is a saturated oil, rich in saturated fatty acids and contains less than 2% linoleic acid, which is an essential fatty acid.

As of now, safflower oil which contains a high percentage of the essential fatty acid, linoleic acid (75%), is considered to be an excellent oil, but of late there are reports that the high linoleic acid content may cause damage to biomembranes and intracellular organelles by the peroxidation products formed (Brisson 1981).

So a study of the fatty acid composition of various oils by the standardized method used in our laboratory to compare their values with one another was considered useful.

2.0 MATERIALS AND METHODS

2.1 Materials

The five mandate crops sorghum, pearl millet, chickpea, pigeonpea, and groundnut chosen for the determination of fatty acid composition were grown at ICRISAT Center. All other vegetable oils used were obtained from reliable sources and are of standard brands, purchased from the local market.

2.2 Methods

2.3. Fatty acid determination

The triglycerides were converted to their fatty acid methyl esters using sodium hydroxide in methanol and BF_3 (boron trifluoride) in methanol followed by extraction with petroleum ether. Fatty acids were determined in a gas chromatograph as described earlier.

3.0 RESULTS AND DISCUSSION

The five ICRISAT mandate crops had considerable amounts of palmitic, oleic and linoleic acids with varying percentages, including some other fatty acids (Table 28).

The percentage of palmitic acid, which is a common fatty acid of all the five crops was highest in pearl millet (19.5%) and lowest in chickpea (9.7%). Lauric, myristic, and palmitic acids are the saturated fatty acids present in most triglycerides, of which palmitic acid is essentially present in almost all the oils and fats. Palmitoleic acid is present in pearl millet, sorghum and chickpea in the range of 0.2 to 0.6%

Table 28. Fatty acid composition of ICRISAT mandate crops[1]

Fatty acid (%)	Sorghum (SPV 351)	Millet (ICH 451)	Chickpea (G-130)	Pigeonpea (C 11)	Groundnut (Kadiri 3)
Myristic	-	-	0.2±0.00	-	-
Palmitic	12.0±0.16	19.5±0.02	9.7±0.00	18.5±0.07	14.2±0.03
Palmitoleic	0.3±0.07	0.6±0.00	0.2±0.00	-	-
Stearic	1.1±0.02	5.1±0.02	0.9±0.01	3.8±0.07	2.3±0.00
Oleic	39.0±0.51	26.6±0.05	19.6±0.02	10.4±0.22	37.1±0.04
Linoleic	41.5±0.35	43.8±0.08	64.4±0.03	58.7±0.16	38.7±0.02
Linolenic	2.9±0.02	2.6±0.01	3.7±0.01	4.6±0.02	-
Arachidic	-	1.1±0.00	0.2±0.00	1.1±0.03	1.4±0.01
Eicosenoic	-	-	-	-	1.4±0.01
Behenic	-	0.2±0.00	0.3±0.01	1.1±0.01	3.2±0.01
Lignoceric	0.5±0.02	0.4±0.01	0.7±0.01	1.5±0.03	1.7±0.01
O/L ratio	0.94±0.007	0.61±0.000	0.31±0.00	0.18±0.006	0.96±0.00

1. Means of three replicates

The names of cultivars are given in parentheses

but not detected in pigeonpea and groundnut. The most important factor, which is considered for the oil quality studies is the O/L ratio. The O/L ratio of pigeonpea and chickpea oil was found to be less than 0.5, while O/L ratio of oil samples from pearl millet, sorghum and groundnut, ranged from 0.61 to 0.96. A comparative study of all the five ICRISAT mandate crops showed that pigeonpea and chickpea were rich in polyunsaturated fatty acids, that is oleic, linoleic and linolenic acid and would contribute very well to the nutritional quality of the seed (Table 28).

The fatty acid compositions of some of the common vegetable oils, sesame, sunflower, safflower, coconut, groundnut, soybean, maize, mustard, palm and rice bran are shown in Tables 29 and 30.

Safflower oil contained the highest percentage of the essential fatty acid, linoleic acid (75%). Soybean oil contained a good percentage of linoleic acid (54.0%), and had, in addition about 7.4% linolenic acid, which contributes to the oxidative degradation of the oil.

Mustard oil, which contains a high content (47%) of erucic acid (22:1) has been reported to cause cardiac lipidosis in rats, but is still used in the north-eastern parts of India.

Much importance is being given to lipids and their use as dietary fat and consumption of polyunsaturated fatty acids is recommended. Animal fats, like ghee and butter are rich in saturated fatty acids, and vegetable fats or oils are rich in

Table 29. Fatty acid composition of commonly consumed oils

Fatty acid (%)	Sesame (Gingelly)	Sunflower (Sunola)	Safflower (Saffola)	Coconut	Groundnut (H & FS)
Caprylic (8:0)	-	-	-	7.8	-
Capric (10:0)	-	-	-	5.6	-
Lauric (12:0)	0.1	-	-	47.6	-
Myristic (14:0)	0.1	-	-	19.6	-
Palmitic (16:0)	10.0	5.5	6.0	8.5	13.3
Palmitoleic (16:1)	0.3	0.2	0.1	-	-
Stearic (18:0)	6.8	3.6	2.3	2.8	4.0
Oleic (18:1)	43.6	41.8	13.8	6.5	40.2
Linoleic (18:2)	37.4	47.1	75.3	1.7	33.2
Linolenic (18:3)	-	-	-	-	-
Arachidic (20:0)	0.9	0.1	0.1	0.1	1.9
Eicosenoic (20:1)	0.5	0.2	0.2	-	1.1
Behenic (22:0)	0.1	0.8	0.3	-	3.9
Erucic (22:1)	-	-	-	-	-
Lignoceric (24:0)	0.2	0.7	1.7	-	1.8
O/L ratio	1.2	0.9	0.2	3.9	1.3

Trade names where applicable are given in parentheses
Source where not indicated : commercial outlets
(H & FS) : Housing and Food Services, ICRISAT

Table 30. Fatty acid composition of commonly consumed oils.

Fatty acid (%)	Soybean (IS 7244)	Maize (Rohini)	Mustard (Rapeseed)	Palm	Rice bran
Caprylic (8:0)	-	-	-	-	-
Capric (10:0)	-	-	-	-	-
Lauric (12:0)	-	-	-	0.3	0.2
Myristic (14:0)	-	-	-	1.1	0.4
Palmitic (16:0)	12.6	14.6	2.0	39.7	19.5
Palmitoleic (16:1)	-	-	0.2	-	-
Stearic (18:0)	3.5	3.6	1.1	4.1	2.3
Oleic (18:1)	21.0	31.2	10.6	42.4	41.4
Linoleic (18:2)	54.0	48.0	13.4	11.1	31.2
Linolenic (18:3)	7.4	1.4	(19.0)[1]	-	-
Arachidic (20:0)	0.2	0.8	-	0.4	1.1
Eicosenoic (20:1)	-	-	(19.0)[1]	0.4	2.2
Behenic (22:0)	0.5	0.2	1.1	0.1	0.4
Erucic (22:1)	-	-	47.0	-	-
Lignoceric (24:0)	0.6	0.2	0.7	0.1	0.7
O/L ratio	0.4	0.7	0.8	3.9	1.4

1. Includes C 18:3 and C 20:1

Trade names where applicable are given in parentheses
Source where not indicated : commercial outlets

polyunsaturated fatty acids, except for coconut oil and palm oil. The significance of the polyunsaturated/saturated fatty acid ratio on the serum cholesterol and total dietary cholesterol and their effect on the development of the diseases, atherosclerosis and the coronary heart disease has been discussed in detail (Brisson, 1981).

References

Abdellatif, A.M.M., and Vles, R.O. 1970. Pathological effects of dietary rapeseed oil in rats. Nutrition and Metabolism. 12:285-295.

Brisson, Germain J. 1981. Lipids in human nutrition. (Brisson, G.J. ed.) Eaglewood, New Jersey. Jack K. Burgess Inc. USA.

Kim, H.K., and Kritchevesky, D. 1983. Lipolysis of corn, peanut and randomized peanut oils. Lipids 18(11):842-844.

SECTION VI. OIL CONTENT, PROTEIN CONTENT, AND FATTY ACID COMPOSITION OF GRADED SAMPLES

VI. OIL CONTENT, PROTEIN CONTENT, AND FATTY ACID COMPOSITION OF GRADED SAMPLES

1.0. INTRODUCTION

The effect of seed size on the physicochemical characteristics of groundnut seed was studied by Ponnuswamy and Ramakrishnan (1984). They reported that the seed sizes affect the oil content in groundnut, which in turn depended on the changes in lipid metabolism during seed development and maturation. Relatively low oil values in large and over-mature seeds were reported by Pattee et al. (1974) and the oil value was also related to the maturity of the seed (Pattee et al 1977). The changes in the roasted groundnut flavor and other factors with seed size were observed by Pattee et. al. (1982).

The relationship between the seed size and its characteristics may vary depending on the property to be studied. Our aim of this investigation was to study the effect of seed size on the oil and protein contents of groundnut.

2.0 MATERIALS AND METHODS

2.1 Materials

Seven groundnut cultivars ICGS 1, ICGS 5, ICGS 11, ICGS 21 and ICGS 44 including two controls, Kadiri 3, and J 11, grown at ICRISAT Center during the 1987/88 postrainy and 1988 rainy seasons were chosen for this study.

2.2 Methods

2.2.1 Grading of the groundnut cultivars

Groundnut kernels were passed through sieves of 5 different mesh sizes with pore dimensions of 16/64" x 3/4", 17/64" x 3/4", 18/64" x 3/4", 19/64" x 3/4", 20/64" x 3/4" and leftovers on top of 20/64" x 3/4" were treated as a separate sample. The different sizes of groundnut seeds obtained were analyzed in duplicate as follows :

2.2.2 Determination of oil, protein, and moisture contents

Oil, protein and moisture contents were determined by the procedures described earlier in this report.

2.2.3 Fatty acid composition

The oil obtained from the six graded samples was analyzed for its fatty acid composition and O/L ratio as described earlier.

2.2.4 Correlation matrix relating 100 seed mass with oil characteristics

The correlation coefficients relating the 100 seed mass with percentages of oil, protein, and O/L ratio in the graded samples of 7 groundnut cultivars were calculated. Statistical analysis using Duncan's multiple range test was carried to study the variation of quality characteristics among cultivars and also to study the variation of these characteristics with seed size.

3.0 RESULTS AND DISCUSSION

The oil %, protein %, moisture %, 100 seed mass, O/L ratio, and fatty acid composition of the 7 cultivars are shown in Table 31. A similar analysis was carried out on the graded samples and data obtained are shown in Table 32. It is evident from the data that, as the size of groundnut kernels increased, the 100 seed mass increased, as expected and so was the oil content. Lipid content in oil seeds depends primarily on the fat deposition. Apparently, the smaller seeds got harvested before the completion of this period and thereby remained under-developed exhibiting small size and comparatively less oil content. In the six graded groundnut samples, an increase in the oil content and a decrease in the protein and moisture contents was seen within each of the cultivars as the size of the groundnut kernels increased. There was not much variation in the O/L ratio, which ranged from 1.02 to 1.05 across the sizes. A significant observation was that, ICGS 21, showed a high 100 seed mass and had the highest O/L ratio among all the cultivars.

The correlation matrix of 100 seed mass with oil percentage, protein content and O/L ratio of the graded groundnut samples of 7 cultivars is shown in Table 33. The relationship of 100 seed mass with oil content was highly significant ($r=0.96$; $P<0.01$) among the 7 cultivars, and across the two seasons. The correlation of the 100 seed mass and O/L ratio was ($r=0.84$; $P\leq 0.01$) and significant in the 1987 postrainy crop. Similarly, the 100 seed mass and protein content were negatively correlated (r=-

Table 31. One hundred seed mass, oil%, protein %, moisture %, O/L ratio, and fatty acid

ition of seven groundnut cultivars

	Cultivars					Controls	
	ICGS 1	ICGS 5	ICGS 11	ICGS 21	ICGS 44	Kadiri 3	J 11
100 seed mass (g)	41.7^{b}	42.6^{b}	42.9^{b}	47.1^{a}	42.6^{b}	42.9^{b}	34.6^{c}
Oil (%)	49.0^{c}	48.0^{e}	49.2^{b}	50.2^{a}	47.9^{f}	48.8^{d}	50.7^{a}
Protein (%)	23.1^{d}	23.7^{a}	23.7^{b}	20.5^{g}	22.5^{e}	21.8^{f}	23.1^{c}
Moisture (%)	5.45^{c}	5.25^{f}	5.06^{g}	5.25^{e}	5.49^{b}	5.27^{d}	5.56^{a}
O/L ratio	0.94^{d}	0.92^{e}	0.93^{e}	1.36^{a}	0.96^{c}	0.94^{d}	1.23^{b}
Palmitic (16:0)	12.27^{c}	12.40^{b}	12.15^{c}	10.82^{e}	12.43^{b}	12.97^{a}	12.06^{c}
Stearic (18:0)	2.28^{e}	2.34^{d}	2.24^{f}	2.69^{b}	2.33^{d}	2.53^{c}	4.87^{a}
Oleic (18:1)	37.20^{c}	36.68^{d}	36.92^{d}	45.21^{a}	37.44^{c}	36.80^{d}	40.92^{b}
Linoleic (18:2)	39.51^{b}	39.97^{a}	39.96^{a}	33.22^{e}	38.90^{d}	39.35^{c}	33.30^{e}
Arachidic (20:0)	1.44^{b}	1.42^{e}	1.42^{e}	1.47^{b}	1.42^{e}	1.45^{c}	2.12^{a}
Eicosenoic (20:1)	1.43^{a}	1.37^{c}	1.44^{a}	1.37^{c}	1.41^{b}	1.28^{d}	0.90^{e}
Behenic (22:0)	3.24^{b}	3.22^{b}	3.21^{b}	3.04^{c}	3.23^{b}	3.06^{c}	3.74^{a}
Lignoceric (24:0)	1.85^{b}	1.75^{d}	1.81^{b,c}	1.51^{e}	1.96^{a}	1.80^{c}	1.50^{e}

Values with the same superscript do not differ significantly

Table 32. One hundred seed mass, oil%, protein %, moisture %, O/L ratio, and fatty acid composition of graded groundnut seed

	Size					
	16/64"	17/64"	18/64"	19/64"	20/64"	>20/64"
100 seed mass (g)	30.52^{f}	34.53^{e}	38.88^{d}	43.56^{c}	48.31^{b}	58.03^{a}
Oil (%)	45.6^{f}	47.4^{e}	48.6^{d}	50.0^{c}	50.8^{b}	51.9^{a}
Protein (%)	23.17^{a}	22.87^{b}	22.69^{c}	22.34^{d}	22.32^{e}	22.24^{f}
Moisture (%)	5.54^{a}	5.41^{b}	5.33^{c}	5.26^{d}	5.25^{e}	5.19^{f}
O/L ratio	1.02^{a}	1.04^{b}	1.04^{a,b}	1.05^{a}	1.05^{a,b}	1.04^{a,b}
Palmitic (16:0)	12.41^{a}	12.29^{b}	12.21^{b}	12.08^{c}	12.02^{c}	11.93^{d}
Stearic (18:0)	2.83^{a}	2.81^{a}	2.78^{b}	2.75^{c}	2.71^{d}	2.49^{e}
Oleic (18:1)	37.96^{c}	38.47^{b}	38.66^{b}	38.98^{a}	39.04^{a}	39.20^{a}
Linoleic (18:2)	37.71^{b}	37.68^{b}	37.71^{b}	37.73^{b}	37.82^{b}	38.18^{a}
Arachidic (20:0)	1.56^{a}	1.54^{b}	1.54^{b}	1.53^{c}	1.52^{d}	1.46^{e}
Eicosenoic (20:1)	1.38^{a}	1.34^{b}	1.31^{c}	1.30^{c}	1.27^{d}	1.29^{c,d}
Behenic (22:0)	3.55^{a}	3.36^{b}	3.28^{c}	3.18^{d}	3.11^{e}	2.96^{f}
Lignoceric (24:0)	1.80^{a}	1.75^{b,c}	1.79^{b,c}	1.72^{b}	1.72^{b,c}	1.71^{c}

Values with the same superscript do not differ significantly

Table 33. Correlation coefficients of 100-seed mass with percent oil, protein content, and oleic to linoleic acid (O/L) ratio in the graded seed samples of seven groundnut cultivars

Genotype	100 seed mass vs oil content		100 seed mass vs protein content		100 seed mass vs O/L ratio	
	Post rainy 1987/88	Rainy 1988	Post rainy 1987/88	Rainy 1988	Post rainy 1987/88	Rainy 1988
ICGS 1	0.97**	0.96**	0.21	-0.88**	0.85**	-0.03
ICGS 5	0.95**	0.99**	0.01	-0.98**	0.85**	0.02
ICGS 11	0.94**	0.97**	-0.62*	-0.82**	0.88**	0.01
ICGS 21	0.95**	0.98**	0.63*	-0.90**	0.30	0.16
ICGS 44	0.98**	0.96**	-0.55	-0.86**	0.80**	0.09
Controls						
Kadiri 3	0.94**	0.97**	0.42	-0.91**	0.91**	-0.79**
J 11	0.76**	0.95**	0.77**	-0.60*	-0.68*	0.83**

Significant at 0.05 (*) and 0.01 (**) probability levels

0.94, P ≤0.01] in the 1988 rainy season.

References

Pattee, H.E., Johns, E.B., Singleton, J.A., and Sanders, T.H. 1974. Composition changes of peanut fruit parts during maturation. Peanut Science 1:57-62.

Pattee, H.E., Wynne, J.C., Young, J.H., and Cox, F.R. 1977. The seed hull weight ratio as an index of peanut maturity. Peanut Science 4:47-50.

Pattee, H.E., Pearson, J.L., Young, C.T., and Giesbrecht, F.G. 1982. Changes in roasted peanut flavor and other quality factors with seed size and storage time. Journal of Food Science 47:455-456, 460.

Ponnuswamy, A.S., and Ramakrishnan V. 1984. Effect of seed size on physicochemical characteristics of seeds in groundnut (Arachis hypogaea L.) cv POL 1, and TMV 2. The Madras Agricultural Journal 71(10):669-672.

SECTION VII. [redacted]

Page No.

A. Trypsin Inhibitor Activity

B. Phenolic Acids in Seed Coat of Groundnut Cultivars Resistant and Susceptible to Seed Colonization by [redacted] flavus

VII. ANTINUTRITIONAL FACTORS

A. Trypsin Inhibitor Activity

1.0 INTRODUCTION

Groundnut is known to contain certain biologically active antinutritional factors that adversely affect their nutritional value. Trypsin and chymotrypsin inhibitors (protease inhibitors) combine with the enzymes' trypsin and chymotrypsin respectively and inhibit the function of these enzymes which affect the digestibility.

2.0 MATERIALS AND METHODS

2.1 Materials

The concentration of trypsin inhibitor was estimated in five groundnut cultivars ICGS 1, ICGS 5, ICGS 11, ICGS 21, and ICGS 44 and controls J 11, Kadiri 3. These were grown in two different seasons, postrainy 1985/86 and rainy 1988.

2.2 Methods

2.2.1 Trypsin inhibitor activity (TIA)

The casein digestion method was employed for the measurement of TIA in groundnut (Kakade et al. 1969). The method involves the use of 2% casein and the spectrophotometric determination of the breakdown products of trypsin in the presence and absence of the inhibitor. To convert the curvilinear response to a linear one, a mathematical transformation of absorbance readings (A) at 280 nm to $A^{3/2}$ was employed. A linear relationship was obtained between $A^{3/2}$ and the range of enzyme concentrations employed.

Table 34. Trypsin inhibitor activity in groundnut cultivars, postrainy 1985/86 and rainy 1988, ICRISAT Center[1]

Cultivar	TUI/mg meal	TUI/mg protein	TUI/mg meal	TUI mg/protein
	Postrainy 1985/86		Rainy 1988	
ICGS 1	1.3±0.04	3.2±0.09	0.8±0.18	3.2±0.71
ICGS 5	1.6±0.08	3.5±0.15	1.2±0.10	4.3±0.36
ICGS 11	1.2±0.04	2.7±0.09	1.4±0.14	2.6±0.26
ICGS 21	2.1±0.06	4.5±0.13	1.7±0.14	4.5±0.38
ICGS 44	1.1±0.07	2.1±0.13	1.1±0.09	3.6±0.31
Controls				
J 11	2.2±0.02	6.1±0.06	2.2±0.06	8.1±0.23
Kadiri 3	1.3±0.06	3.5±0.16	1.4±0.14	5.2±0.51
Mean±SE[2]	1.6±0.16	3.7±0.49	1.4±0.17	4.5±0.68

1. Means and SE of three replicates
2. Means and SE of seven cultivars

TUI : Trypsin units inhibited

One trypsin unit (TU) is arbitrarily defined as an increase of 0.01 absorbance units at 280 nm in 20 minutes per 10 ml of the reaction mixture under the experimental conditions. Trypsin inhibitor activity can be expressed as the number of trypsin units inhibited either per mg meal or per mg of the extracted protein.

3.0 RESULTS AND DISCUSSION

The trypsin units inhibited/mg meal ranged from 1.1 to 2.2 units with a mean value of 1.6 units for the postrainy 1985/86 season cultivars and from 0.8 to 2.2 units with a mean value of 1.4 units for rainy season 1988 cultivars. Control J 11 showed higher values (2.2, 2.2) in both the seasons (Table 34).

Reference:

Kakade, M.L., Simons, N., and Liener, I.E. 1969. An evaluation of natural vs synthetic substrates for measuring the antitryptic activity of soybean samples. Cereal Chemistry. 46:518-526.

B. Phenolic Acids in Seed Coat of Groundnut Cultivars Resistant and Susceptible to Seed Colonization by *Aspergillus flavus*

1.0 INTRODUCTION

Thirteen groundnut cultivars, eight resistant and five susceptible to *in vitro* seed colonization by *Aspergillus flavus* were analyzed for polyphenols using different methods. No significant correlation was obtained between seed colonization and total polyphenols content in seed coat of these cultivars (Jambunathan et al. 1989). The present investigation was therefore undertaken to determine individual phenolic acids in groundnut samples that were identified to be resistant, and susceptible to seed colonization by *A. flavus*. Reverse phase high performance liquid chromatograph (HPLC) system was used with the following objectives.

a. To try published procedures for the separation and quantification of phenolic acids from the seed coat of groundnut samples.

b. To find out the difference, if any, in the phenolic acids in cultivars that are resistant and susceptible to in vitro *A. flavus* seed colonization.

2.0 MATERIALS AND METHODS

2.1 Materials

Thirteen cultivars, eight resistant, and five susceptible, to *in vitro* colonization by *A. flavus* were grown in the 1985 rainy season at ICRISAT Center and were supplied to us by the Groundnut

Pathology Unit (Table 35).

2.2 Methods

2.2.1 Sample preparation

Seeds from thirteen cultivars grown at ICRISAT Center in four replications were dried in an oven at 40°C overnight. Seed coat was removed manually, ground in a pica mill and defatted. All the four replicates were pooled, and from pooled sample, 250 mg of seed coat was weighed for analysis. In a screw capped test tube, 250 mg seed coat was mixed with 5 ml methanol and contents were shaken for one hour. The supernatant was saved after centrifugation and the residue was re-extracted for 30 minutes. The supernatants were pooled and then filtered through a millipore 0.45 um filter unit.

2.2.2 Standards

Eight phenolic acids, caffeic, protocatechuic, gallic, syringic, vanillic, cinnamic, ferulic, p-coumaric were prepared separately using HPLC grade methanol (0.1 mg/ml stock solution). All the eight standards were pooled and a mixture of samples with 0.1 mg/ml concentration was prepared. All the samples were stored in the freezer. Extraction and analysis were done on same day. Thirty micro liter solutions of reference standard as well as samples were injected into the column using auto injector and samples were usually analyzed by running the HPLC overnight.

2.2.3 Shimadzu unit : A Shimadzu HPLC LC-6A unit, equipped with System controller, and R-Sil, C-18, 10 u column with 25

Table 35. Reaction of groundnut cultivars to in vitro seed colonization by *Aspergillus flavus*

Cultivar	Reaction[1]	Seed colonized
		ICRISAT Center
Ah 7223	R	8.9
J 11	R	10.5
U 4-47-7	R	14.8
UF 71513	R	11.1
PI 337394F	R	11.5
Var 27	R	13.8
ICGS 58	R	13.2
ICGS 78	R	12.5
TMV 2	S	32.4
Faizpur 1-5 x NC Ac 17090	S	33.9
Gangapuri	S	37.4
NC Ac 17090	S	36.5
EC 76446(292)	S	38.0
SE		±3.4

1. R = Resistant; S = Susceptible;

mm length and 4.6 mm ID was used along with a guard column, ODS P/N 228-09613-9 1 (Shimadzu) for the separation of polyphenols.

2.2.4 Solvent gradients: Solvent gradients were formed by dual pumping system by varying the proportion of solvent A and solvent B, and the pressure in the pumps ranged from 0.8 x 100 kg F/Cm^2 to 1.0 x 100 kg F/Cm^2 .

2.2.5 Elution: Mobile phase consisted of two solvents A and B. Solvent A contained 98% water and 2% glacial acetic acid with 0.018 M ammonium acetate. Solvent B was a mixture of 70% solvent A and 30% of organic solvent containing 82% methanol, 16% n-butanol, and 2% glacial acetic acid with 0.018 M ammonium acetate. Ammonium acetate was added to prevent intra-molecular bonding of phenolic hydroxyl groups which increased the sharpness of the peaks. All the solvents were filtered through a 0.45 micron millipore filter and degassed with helium for 15 to 20 min.

The initial flow rate for all gradients was 1 ml/min. The gradient elution consisted of following steps.

a. 0.0 to 1.0 min. isocratic 10% solvent B.

b. 1.0 to 21.0 min. linear gradient from 10 to 25% solvent B.

c. 21 to 36 min. linear gradient from 25 to 45% solvent B.

d. 36 to 56 min. linear gradient from 45 to 100% solvent B.

e. 50 to 50.15 min flow increased from 1 to 1.20 ml/min.

f. 82 to 82.15 min linear gradient from 100 to 10% solvent B.

Table 36. Methods that were tried for the separation and identification of polyphenols extracted from groundnut seed coat

Reference[1]	Column used	Run time (min)	Flow rate (min)	Mobile phase (solvent system)	Wave length (nm)	Instrument used	Remarks
Benwart, WL 1985	C-18 ultra-sphere ODS column	99	1.0/min	2% acetic acid 0.018 M ammonium acetate (A) (B) 70% of A and 30% of O (O) 82% of methanol 16% n-butanol 2% acetic acid 0.018 M ammonium acetate	254 and 280	Beckman	good elution for standards as well as sample
Brad Murphy J. 1978	Non polar Bondpak C-18 (Waters Associates)	55	1ml/min	Gradient elution, 2% acetic acid 40% methanol BAMW 1:5:2:92 Butanol, acetic acid, methanol and water With .018 M Ammonium acetate	254	Waters Associates	Better resolution for reference standards not for sample
Hardin, JK 1980	Bondpak C-18	40	1ml/min	2% acetic acid 10 min followed by 20 min. gradient BAMW30 Butant acetic acid methanol and water	254	Waters Associates	Resolved reference standards, not samples
Hartley, RD 1980	Spherisorb Bonded phase C-18	-	1.2 ml/min	Isocratic elution two solvents 342:1:14 and 347:1:11 Water : acetic acid : butanol	275	Fabricated equipment	Resolved only two peaks p-coumaric and ferulic
Haun, DH 1983	Nonpolar u Bondpak C-18 column Water Associates	55	1ml/min	Multistep gradient 2:98 Acetic acid, water 8:92 Butanol, methanol	254	Beckman	High back pressure
Nicholson, RL		-	1ml/min	1. Water 50%, 2. Methanol 5% Isocratic and gradient 65:35		-	High back pressure
Bee, A 1984	u-ultrasphere ODS C-18 (4.6 x 150 cms)	55	1.0 ml/min	1. 95:5 water, methanol 2. methanol 95:5 acetic acid 0 to 100% gradient	280		Erratic base line
Shimadzu Handout Application Notes	ODS column	30	1.2 ml and altered as 0.5, 0.8, 1.0/min	1. 80:20 methanol, water 2. 50:50 methanol, water gradient 1%/min	254 and 320	Shimadzu	High back pressure no change after altering flow rate

1. Column, instrument, and other details as published are cited here.

g. 92 to 92.15 min flow decreased to 1.0 ml/min.

h. 99 min sample loop is rinsed and gradient was repeated.

2.2.6 Detection

Absorbance of samples as well as reference standard was detected at 280 nm, (attenuation 4).

2.2.7 Calculation

Eluted phenolic compounds were monitored at 280 nm and the area of the peaks was automatically calculated by the integrator.

$$\% \text{ Phenolic acid} = \text{dilution factor} \times \frac{\text{peak area of sample}}{\text{peak area standard}}$$

2.2.8 Method development

Methods cited in the attached Table 16 were tried one by one unsuccessfully, and due to high back pressure and poor resolution, were not found suitable. Banwart et al (1985) method of multigradient system with 2 detectors and dimethyl sulfoxide (DMSO) as extractant was tried and was found to give satisfactory results. This method was therefore used with some modifications which included the measurement at 280 nm, and the extraction of sample was made in pure methanol. The separation of standard mixture was excellent. The sample resolution was better but all the peaks were not fully resolved.

3.0 RESULTS AND DISCUSSION

The chromatograms of samples obtained were corrected for base line using pure methanol as a blank. Each standard, standards

Table 37. Retention time of polyphenols when applied separately or in a mixture

Phenolic acids	Individual (retention time, min)	Mixture (retention time, min)
Gallic acid	8.1	8.5
Protocatechuic acid	14.7	14.9
Vanillic acid	31.4	31.5
Caffeic acid	34.7	34.9
Syringic acid	35.5	36.1
P-coumaric acid	47.1	47.0
Ferulic acid	50.1	50.1
Cinnamic acid	67.6	67.3

mixture (Table 37) and samples were analyzed in triplicate (Table 38). Standards were run before and after analysis of samples.

Gallic acid was run several times to check the reproducibility and linearity of the instrument. Sample peaks having the retention times of the reference standard peaks were identified as ferulic and p-coumaric acids which resolved at 47 and 49 min respectively. In some runs, these peaks did not separate well. Data obtained from 3 runs were pooled for ferulic and p-coumaric acid and SD and SE were calculated. The percentage of ferulic and p-coumaric acids in seed coat samples ranged from 0.23 to 1.56% (Table 38).

Overall, the mean value of ferulic plus p-coumaric acids was 0.77% in resistant cultivars and 0.94% in susceptible cultivars. There were many unidentified peaks which emerged at 26, 38, 41 43, and 45 min. None of the standard phenolics that were used in the present investigation could be used to identify those peaks. Representative high-performance liquid chromatography patterns obtained with standard polyphenols (Fig. 1), a resistant cultivar (Fig. 2), and a susceptible cultivar (Fig. 3) are included.

References

Banwart, W.L., Porter, P.M., Granato, T.C., and Hasette, J.J. 1985. HPLC separation and wave length area ratios of more than 50 phenolic acids and flavanoids. Journal of Chemical Ecology 11:383-395.

Table 38. Concentration of ferulic plus p-coumaric acids [$g(100.g)^{-1}$] in the seed coat of groundnut cultivars

Cultivar	Reaction	Mean[1]	SE
AH 7223	R	0.60	±0.035
J 11	R	0.65	±0.075
U 4-47-7	R	0.65	±0.058
UF 71513	R	0.72	±0.058
P 337394F	R	0.79	±0.127
VAR 27	R	0.38	±0.075
ICGS 58	R	1.02	±0.092
ICGS 78	R	1.34	±0.069
TMV 2	S	0.57	±0.029
Faizpur 1-5 XNC AC 17090	S	0.82	±0.075
Gangapuri	S	0.23	±0.040
NC AC 17090	S	1.51	±0.179
EC 76446 (292)	S	1.56	±0.352

[1] Mean of three runs

Mean of resistant cultivars : 0.77
Mean of susceptible cultivars : 0.94

R - Resistant; S - Susceptible

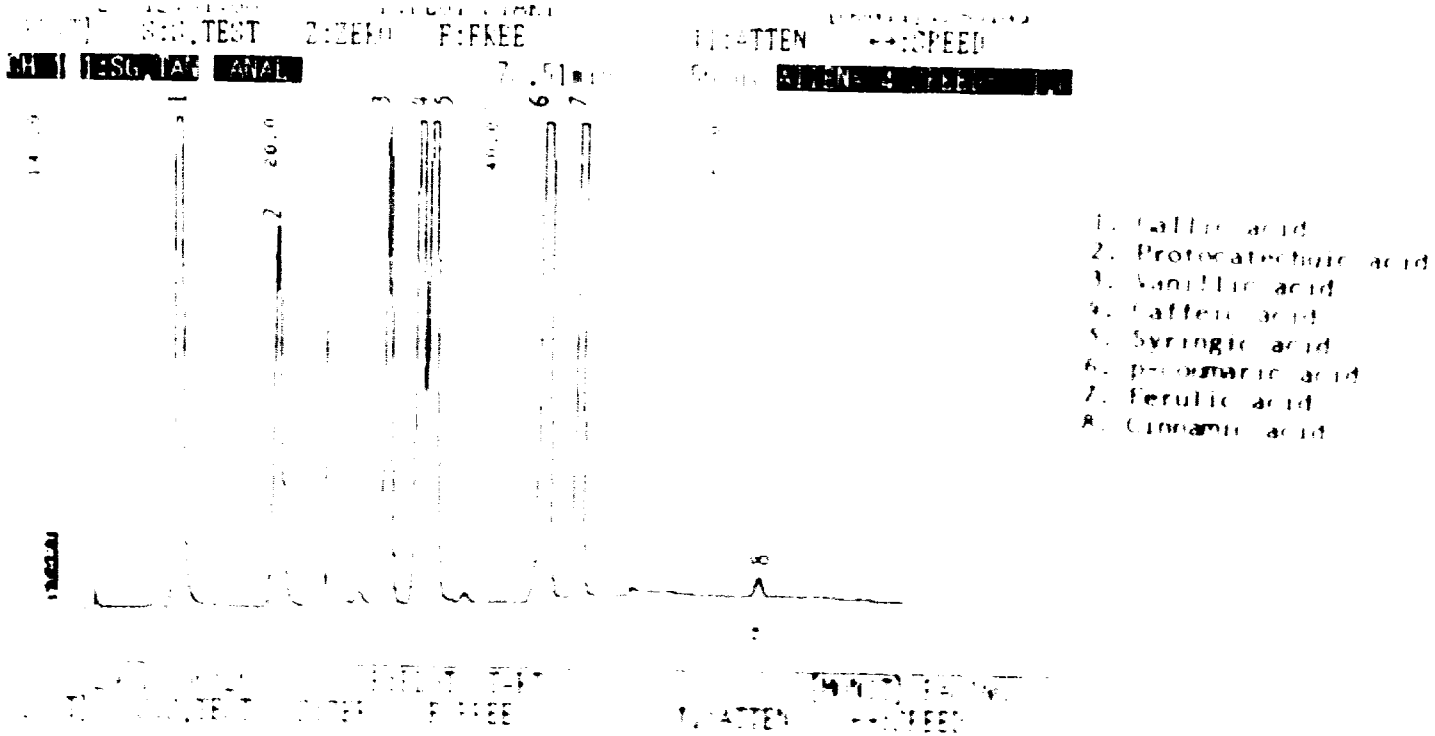

Figure 1. High-performance liquid chromatography of standard polyphenols.

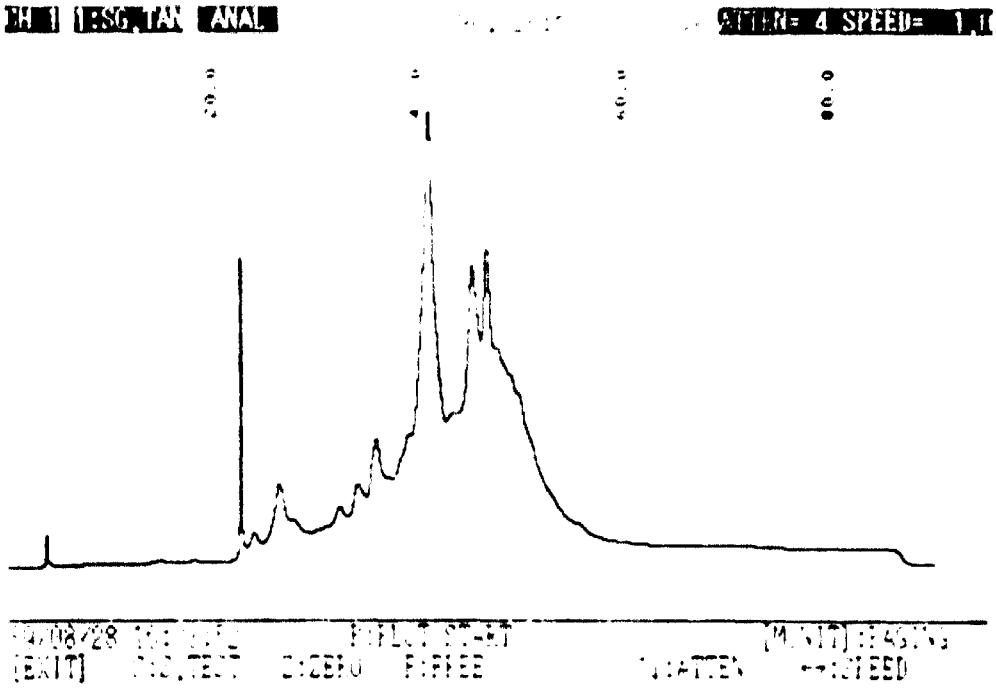

Figure 2. High-performance liquid chromatography of a resistant groundnut cultivar, Ah 7223.

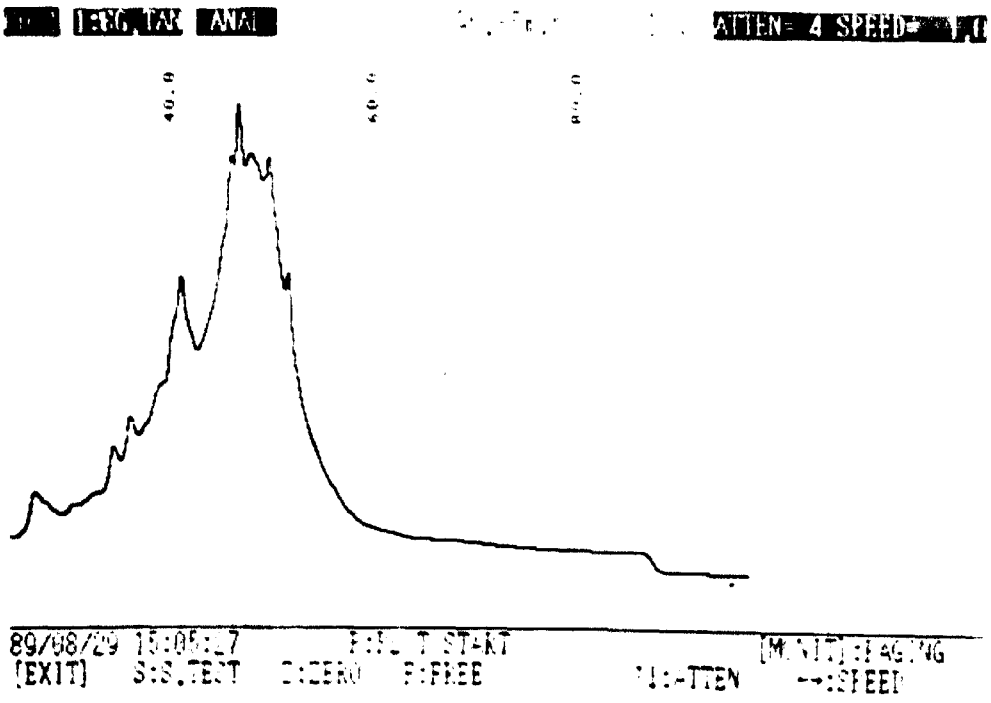

Figure 3. High-performance liquid chromatography of a susceptible groundnut cultivar, EC 76446(292).

Brad Murphy, J., and Stutte, C.A. 1978. Analysis for substituted benzoic and cinnamic acids using high pressure liquid chromatography. Analytical Biochemistry 86:222-228.

Hardin, J.M., and Stutte, C.A. 1980. Analysis of phenolics and flavanoid compounds by high pressure liquid chromatography. Analytical Biochemistry 102:171-175.

Hartley, R.D. 1987. HPLC for the separation and determination of phenolic compounds in plant cell wall. Page 98 in Modern Methods of Plant Analysis, New Series Vol 5. Springer Verlog Berline Heidlburg, New York.

Haun, D.H., Faubion, J.M., and Rooney, L.W. 1983. Sorghum phenolic acids, their high performance liquid chromatography separation and their reaction to fungal resistance. Cereal Chemistry 40(4):255-259.

Jambunathan, R., Mehan, V.K., and Santosh Gurtu. 1989. Polyphenols in groundnut genotypes resistant and susceptible to seed colonization by Aspergillus flavus. Pages 357-364 in Aflatoxin Contamination of Groundnuts: Proceedings of the International Workshop, 6-9 Oct 1987, ICRISAT Center, India, Patancheru, A.P. 502 324, India.

Ralph L. Nichlson (personal communication). Solvent programs for separation of sorghum phenolics. Department of Botany and Plant Pathology, Purdue University, Indiana 47907.

Seo, A., Morr, C.V. 1984. Improved HPLC analysis of phenolic acids and isoflavanoids from soybean protein products. Journal of Agricultural and Food Chemistry 32:530-533.

Shimadzu Handout Application Notes. Analysis of phenolic carboxylic acids, Shimadzu, Japan.

SECTION VIII PROTEIN QUALITY EVALUATION

A. Rat Bioassay

B. In → tro Protein Digestibility (IVPD)

VIII. PROTEIN QUALITY EVALUATION

A. Rat Bioassay

1.0 INTRODUCTION

Groundnut is grown as an oil seed crop in many countries of the world. The defatted residue, or groundnut cake, is an abundant and inexpensive source of protein. The utilization of young growing rats for evaluating the protein quality of foods using the biological value (BV) method has been reviewed by McLaughan and Noel (1970). Biological evaluation method is a nitrogen balance technique which distinguishes between ingested protein and absorbed protein. Endogenous nitrogen in urine and faeces is estimated when animals are fed a protein-free diet. The young rats fed on a protein diet put on weight and the ratio of weight gained to protein consumed is expressed as the "protein efficiency ratio" or PER. The PER values were observed to increase with increase in the protein content of the diet up to a maximum value (usually about 9 to 10% protein) and then decreased as the protein level was raised further (McLaughan and Noel, 1970).

When rats are fed on diets containing test protein and nonprotein groups, the efficiency of nitrogen utilization of test protein was assessed as net protein utilization (NPU). True digestibility (TD) and BV are considered the main characteristics of feed protein and the (NPU) is derived from these factors. In contrast to the apparent digestibility (AD), the TD of a protein source is generally considered to be independent of the protein

content of the diet, feed intake, and body weight of the experimental animals (Eggum 1973). The definitions of these terms can be represented as follows:

1.1 Biological Value (BV)

The proportion of absorbed nitrogen that is retained in the body for maintenance and/or growth (FAO/WHO 1965).

$$\frac{I - (F-Fk) - (U-Uk)}{I - (F-Fk)} \quad \text{or} \quad \frac{B-Bk}{I-(F-Fk)}$$

1.2 Net Protein Utilization (NPU)

The proportion of nitrogen intake that is retained, i.e. the product of biological value and digestibility (FAO/WHO, 1965).

$$\frac{I - (F-Fk) - (U-Uk)}{I} \quad \text{or} \quad \frac{B-Bk}{I}$$

1.3 True Digestibility (TD)

Proportion of food nitrogen that is absorbed, (FAO/WHO, 1965).

$$\frac{I - (F-Fk)}{I}$$

1.4 Utilizable Protein (UP)

$$UP = \frac{NPU \times \text{protein \%}}{100}$$

1.5 Protein Efficiency Ratio (PER)

Gain in body weight divided by weight of protein consumed (FAO/WHO, 1965).

1.6 Symbols used

B : Body nitrogen (measured at the end of test period on animals fed with test diet)

Bk : Body nitrogen at zero nitrogen intake (measured at the end of test period on animals fed with non protein diet).

F : Faecal nitrogen

Fk : Endogenous faecal nitrogen

I : Nitrogen intake

U : Urinary nitrogen

Uk : Endogenous urinary nitrogen

Groundnut protein is considered to be of low nutritional quality because several of the essential amino acids are present in limited amounts (Miller and Young, 1977). Lysine and methionine are generally the most limiting amino acids in groundnut (Ibrahim and Canolty, 1985). In addition, threonine, isoleucine, and valine are among the five of the eight essential amino acids shown to be deficient in groundnut. When compared to casein, the accepted reference standard for conducting bioassay for protein efficiency ratio (PER), the biological value of groundnut was found to be 50 to 75% of the standard protein. Such tests are conducted with growth limiting levels of dietary protein and provide little information on the potential capacity

of a protein for supporting the growth. Carpenter and de Muelenaere (1965) concluded that, under certain conditions, higher levels of poor quality proteins would result in nearly as good growth of rats as could be obtained in practical diets containing good-quality proteins. The protein quality of groundnuts might be improved by breeding was shown by Miller et al. (1978) in their work on protein nutritional quality of meal from several groundnut cultivars as measured by rat bioassay. The bioassays of weaning rats fed on 16.7 to 20% groundnut protein were found to be essentially equivalent to those of animals fed on 12-24% casein protein by Miller and Young (1977). They also indicated that methionine, lysine and threonine were limiting and that a portion of the lysine and threonine were biologically unavailable.

2.0 MATERIALS AND METHODS

2.1 Materials

2.1.1 Source of rats and cultivars

The rat feeding trials were carried out on Wistar strain male rats weighing about 60 grams. Casein (Animal and Nutrition Research Council Reference Casein, Sheffield Chemical Company, Union, New Jersey, USA) was used as the reference standard. Rats were obtained from the stock colony being maintained by the Indian Drugs and Pharmaceuticals Limited (IDPL), Hyderabad. The diets included the stock diet and the nitrogen free diet (described below). The groundnut cultivars used for biological evaluation were ICGS 1, ICGS 5, ICGS 11, ICGS 21, and ICGS 44,

and controls used were Kadiri 3 and J 11. All these cultivars were grown during two seasons, the 1985/86 post rainy and 1988 rainy season. Studies on groundnut cultivars from the 1988 rainy season were conducted on blanched and whole seed samples to investigate the effect of seed coat on nitrogen utilization.

2.1.2 Preparation of a stock diet

In general, we followed the method of Eggum (1973) with slight modifications as described. The stock diet for our rat feeding trials was prepared according to the method of Pellet and Young (1980). A stock diet was prepared from wheat (150 g), roasted bengal gram (580 g), groundnut (100 g), skimmed milk powder (50 g), casein (40 g), oil (groundnut oil, refined 40 g), mineral mixture (40 g), choline-chloride (2 g) and vitamin mixture (2 g). Wheat, roasted bengal gram, and groundnut were ground to a fine powder in a Waring blender. Casein, skimmed milk powder, vitamin mixture, oil, mineral mixture, and choline chloride were mixed thoroughly. The two mixtures mentioned above, were mechanically mixed for 30 to 40 min.

2.1.3 Preparation of a nitrogen free diet

Crude potato starch was found to have a negative effect on protein digestibility. So autoclaved starch was used in our studies. Potato starch (Loba Chemicals, Bombay) was mixed with water in the ratio of 3:1 (w/v), autoclaved at 20 lb for 4 hours and dried in an oven at 55^{o}C for 1 or 2 days till the cooked starch dried completely. The autoclaving resulted in a sandy structure of the starch material, which was found to be

advantageous in our feeding techniques, as it does not adhere to spoons, and brushes which helped in quantitative collection. The starch was ground to a fine powder in a Waring blender. The nitrogen free diet had the following composition; sucrose (9.0%), cellulose powder (5.2%), oil (groundnut oil, refined 5.2%) and potato starch (autoclaved 80.6%).

2.1.4 Experimental diet

About 500 g experimental diet, (dry weight basis) was prepared. The nitrogen content of the test material (groundnut flour) was determined. The diet was prepared from groundnut flour equivalent to 7.5 g N (nitrogen), 20 g mineral mixture and 8.0 g vitamin mixture. This was made up to 500 g of experimental diet (dry weight basis) using nitrogen free diet.

2.1.5 Diet for PER

The diet consisted of test material contributing to 10% protein in the diet, mineral mixture 4%, vitamin mixture 1 %, fat 10%, cellulose 5% and made to 100% using corn starch.

2.1.6 Low protein diet

Four percent protein equivalent diet was prepared by adding freeze dried egg white to 20 g of mineral mixture and 5 g of vitamin mixture, and made up to 500 g dry matter using N-free diet.

2.2 Methods

2.2.1 Nitrogen balance assay

Wistar strain male rats were obtained when their body weights

were approximately between 55 and 60 g. The rats were kept in individual cages and fed on a stock diet for 2 days, with a provision for food and water ad libtym during this period. Using a randomized block design, 5 rats were assigned to each experimental diet. The body weights among these rats should not vary more than 5 g within a group and the mean body weights between the groups should not be more than ± 0.5 g. In addition to the test group, another group of rats was fed on a low-protein diet. From the faeces and urine collected from rats, fed on low-protein diet, the metabolic 'N' and endogenous 'N' were calculated.

The experiment lasted for a total of 9 days. The first 4 days were termed as the preliminary period. During this period, the rats were acclimatized to the new surroundings and got used to the test diet. Faeces and urine were not collected during this period.

The rats were then fed a diet of 10 g dry matter daily containing 150 mg 'N' for a period of 5 days and urine and faeces were collected during this period. After 5 days, the left out food was recovered and weighed. Urine and faeces were analyzed for nitrogen using the Technicon auto analyzer. NPU, BV, and TD were calculated using the formula mentioned earlier.

2.2.2 Protein Efficiency Ratio (PER)

Wistar strain male rats of 20-23 days old, each weighing 30-40 g, were procured and kept in individual cages on a stock diet for

Table 39. Biological evaluation of blanched groundnut cultivars, 1985/86 postrainy season, ICRISAT Center[1]

	ICGS 1[2]	ICGS 5	ICGS 11	ICGS 21	ICGS 44	Casein	Mean SE
Biological value (%)	53.5^{b} ± 1.96	52.7^{b} ± 1.12	51.5^{b,c} ± 2.20	56.6^{b} ±1.55	47.7^{c} ± 2.05	76.0^{a} ± 1.57	56.3±4 11
True digestibility (%)	96.3^{b,c} ±0.42	95.4^{c} ± 0.87	98.2^{a,b} ± 1.02	99.2^{a} ±0.36	96.4^{b,c} ± 0.59	96.4^{b,c} ±0.66	96.9±0.58
Net protein utilization (%)	51.5^{b,c} ±1.90	50.3^{b,c} ±1.26	50.7^{b,c} ±2.07	56.1^{a} ±1.67	46.0^{c} ±1.93	73.3^{a} ±1.59	54.7±3.96
Utilizable protein (%)	25.1^{b,c} ±0.93	25.4^{b,c} ±0.64	24.7^{c} ± 1.18	28.4^{a} ±0.83	22.8^{c} ±0.97	64.3^{a} ±0.98	31.7±6.55
Protein (%)	48.7	50.5	48.8	50 0	49.5	87.8	55.8±6.40
Protein efficiency ratio	2.41^{b} ±0.073	2.42^{b} ±0 069	2.35^{b} ±0 069	2.33^{b} ±0.080	2.28^{b} ±0.073	3.21^{a} ±0.049	2.50±0.144

Values with the same superscript do not differ significantly

1. Means of 5 determinations
2. Means of 4 determinations

two days. Food and water were provided ad libtum during this period. Using randomized block design, 10 rats were assigned to each experimental diet with the differences in body weight of individuals of not more than about 5 g within a group and 2 g between groups.

This experiment was conducted for 28 days. During this period, food and water were provided ad libtum. After the completion of 28 days, the food consumption of individual rats and weight gained by them were recorded. PER was calculated using the formula mentioned earlier. The average values from 10 rats were reported as the PER value.

3.0 RESULTS AND DISCUSSION

The bioassay of groundnut cultivars grown during the 1985/86 postrainy season was carried out on blanched sample and the results are shown in Table 39. ICGS 21 was unique in showing the highest BV, TD, NPU, and UP. The lowest values of BV, NPU, and UP were in the case of ICGS 44. The values for BV, NPU and UP of three cultivars ICGS 1, ICGS 5 and ICGS 11 did not differ significantly. There were no significant differences in PER among ICRISAT cultivars which ranged from 2.28 to 2.42. The amount of protein in the 5 cultivars varied from 48.7 to 50.5%. These experiments demonstrated that groundnut protein has an excellent digestibility (above 95%) and could be effectively utilized as a dietary substitute with a NPU of around 50%. The utilizable protein among the five groundnut cultivars ranged from 22.8 to 28.4%.

Table 40. Biological evaluation of whole seed groundnut cultivars, rainy season, 1988, ICRISAT Center

	ICGS 1[1]		ICGS 5[2]		ICGS 11[1]		ICGS 21[2]		ICGS 44[1]		
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean[3] ± SE[3]
Biological value (%)	64.1[a]	±1.53	65.8[a]	±1.52	61.3[a]	±2.83	64.9[a]	±1.15	62.3[a]	±0.55	63.7±0.83
True digestibility (%)	90.3[a]	±1.28	92.5[a]	±1.13	90.7[a,b]	±1.78	87.8[b]	±0.45	91.7[a]	±0.86	90.6±0.80
Net protein utilization (%)	57.9[a]	±1.24	60.9[a]	±1.85	55.9[a]	±3.46	57.0[a]	±1.05	57.2[a]	±1.66	57.8±0.84
Utilizable protein (%)	22.3[a,b]	±0.49	25.1[a]	±0.84	23.8[a,b]	±1.48	21.9[b]	±0.40	23.7[a,b]	±0.35	23.4±0.57

1. Means of 4 determinations
2. Means of 5 determinations
3. Means and SE of five cultivars

Values with the same superscript do not differ significantly

The biological evaluation of the groundnut cultivars grown during the 1988 rainy season was carried out on blanched and whole seed samples, and the results are shown in Tables 40 and 41. Though there were no significant differences in BV, TD, and NPU among the whole seed cultivars belonging to 1988 rainy season, ICGS 5 had the highest BV,TD, NPU and UP percentages among the cultivars (Table 40).

In contrast to the earlier results of blanched cultivars belonging to 1985/86 postrainy season where ICGS 21 showed high NPU, BV, and TD, there were no significant differences among the blanched cultivars in NPU, BV, and TD percentages in the 1988 rainy season cultivars. ICGS 1 had the highest percentages of BV, NPU, TD, and UP (Table 41).

To study the role of the seed coat on the digestibility and net protein utilization gorundnuts, bioassays were carried out under identical conditions on the blanched and whole seed samples obtained from the 1988 rainy season (Table 42). True digestibility was less in whole seed samples than blanched samples in all the cultivars. The lower digestibilty in the case of whole seed sample could be due to the presence of certain protein inhibitors, polyphenols and tannins as reported earlier. Interestingly, the biological value of the whole seed samples was higher than the blanched samples except in the case of ICGS 21. Also, there was not much variation in the net protein utilization. Utilizable protein was higher in blanched samples than the whole seed samples. The values of TD and UP of blanched

Table 41. Biological evaluation of blanched groundnut cultivars, rainy season 1988, ICRISAT Center[1]

	ICGS 1		ICGS 5		ICGS 11		ICGS 21		ICGS 44		Kadiri 3		Controls J 11		
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean SE
Biological value (%)	64.2[a]	±1.78	60.9[a]	±1.15	61.6[a]	±1.77	60.9[a]	±0.96	61.5[a]	±2.48	61.0[a]	±1.87	63.6[a]	±1.06	62.0±0.52
True digestibility (%)	93.9[a]	±0.97	93.2[a]	±1.12	93.4[a]	±0.32	91.8[a]	±1.17	92.4[a]	±1.27	93.0[a]	±0.65	93.4[a]	±0.63	93.0±0.27
Net protein utilization (%)	60.3[a]	±1.92	55.5[a]	±1.58	57.5[a]	±1.69	56.0[a]	±1.33	56.7[a]	±1.50	56.7[a]	±1.93	59.4[a]	±1.17	57.4±0.67
Utilizable protein (%)	25.6[a]	±0.82	23.7[a,b]	±0.68	24.7[a]	±0.72	22.2[a]	±0.53	24.0[a]	±0.64	24.6[a]	±0.83	23.9[a,b]	±0.48	24.1±0.40
Protein (%)	42.5		42.7		43.0		39.8		42.3		43.4		40.2		42.0±0.53

Values with the same superscript do not differ significantly

1. Means of 5 determinations except in the case of ICGS 1 (4 determinations)

Table 42. Biological evaluation of blanched and whole seed groundnut cultivars, rainy season 1988, ICRISAT Center[1]

	ICGS 21		J 11		*Kadiri 3			
	Blanched	Whole seed	Blanched	Whole seed	Blanched	Whole seed	Mean	
	Mean SE	Mean SE	Mean SE	Mean SE	Mean SE	Mean SE	Blanched	Whole seed
Biological value (%)	60.9±0.96	58.4±0.45	63.6±1.06	67.1±0.89	61.0±1.87	66.2±0.82	61.8±0.88	63.9±2.76
Net protein utilization (%)	56.0±1.33	51.1±0.67	59.4±1.17	60.8±1.33	56.7±1.93	59.0±0.80	57.4±1.04	57.0±2.98
True digestibility (%)	91.8±1.17	87.6±0.68	93.4±0.63	90.6±1.41	93.0±0.65	89.0±0.31	92.7±0.48	89.1±0.87
Utilizable protein (%)	22.2±0.53	18.8±0.24	23.9±0.48	23.7±0.52	24.6±0.83	22.3±0.31	23.6±0.71	21.6±1.46

1. Means of 5 determinations. This experiment was carried out at the same time on blanched and whole seed samples

ICGS 21 sample were significantly higher than the values obtained with the whole seed. The values of BV, TD, and UP of blanched Kadiri 3 sample were significantly higher than the values obtained with the whole seed. No significant differences were obtained in the data obtained with J 11.

References

Carpenter, K.J., and de Muelenaere, H.J. 1965. A comparative study of performance of high protein diets of unbalanced amino acid composition. Proceedings of Nutrition Society 24:202-209.

Eggum, B.O. 1973. A study of certain factors influencing protein utilization in rats and pigs (Eggum, B.O. ed.) I. Kommission hos Landhusholdningsselekabets Forlag, Kobenhavn, V. 173 pp.

Ibrahim, H.S., and Canolty, N.L. 1985. Effects of energy intake and dietary protein concentration on utilization of peanut protein in rats. Nutritional Reports International 31:677-686.

Mclaughan, J.M., and Noel F.F., 1970. The effect of protein level on the measurement of net protein utilization in young rats. Nutrition Reports International vol. II. 5:281.

Miller, J., and Young, C.T. 1977. Protein nutritional quality of florunner peanut meal as measured by rat bioassay. Journal of Agricultural and Food Chemistry 25:653-657.

Miller J., Dixon Phillips, R., and Young, C.T. 1978. Protein nutritional quality of meal made from several cultivars of peanuts as measured by rat bioassay. Peanut science 3:19-22.

Pellet, P.L., and Young, V.R. 1980. Nutritional evaluation of protein foods. Food Nutrition Bulletin Supplemnet. 4. The United Nations University, Tokyo, Japan 154 pp.

B. *In Vitro* Protein Digestibility

1.0 INTRODUCTION

The *In vitro* protein digestibility (IVPD) of groundnut cultivar was carried out for estimating the protein digestibility. IVPD can be a rapid and convenient way to estimate protein digestibility and IVPD values are reported to be comparable to *in vivo* methods using rats. In IVPD, proteins are digested by the enzyme, pepsin, at acidic pH (pH=2.0) and the amount of protein digested or that remaining in the residue is determined to calculate the percentage of digestibility.

2.0 MATERIALS AND METHODS

2.1 Materials

Five groundnut cultivars (ICGS 1, ICGS 5, ICGS 11, ICGS 21, and ICGS 44) and controls Kadiri 3 and J 11 grown at ICRISAT Center, during the 1985/86 postrainy season were studied and casein (Sigma) was used as the standard.

2.2 Methods

We used the method as described by Axtell et al. (1981).

2.2.1 Procedure

One hundred milligrams of defatted groundnut flour was weighed into a centrifuge tube and 20 ml of pepsin reagent added. The tubes were then capped and shaken on a shaker-incubator water bath at 37°C for 3 hours. A blank run of pepsin reagent was used. After cooling, 5 ml of 50% TCA was added, the mixture was filtered and 10 ml of the clear aliquot pipetted into a Technicon

Table 43. *In vitro* protein digestibility (IVPD) of groundnut cultivars, postrainy season 1985/86, ICRISAT Center[1]

Cultivar	Digestibility	
	Mean	SE
ICGS 1	84.8	±0.96
ICGS 5	84.1	±0.00
ICGS 11	86.4	±1.26
ICGS 21	85.2	±1.26
ICGS 44	86.4	±1.89
Controls[2]		
Kadiri 3	86.5	±0.00
J 11	85.5	±0.23
Casein	91.9	±1.11
Mean±SE[3]	85.6	±0.35

1. Means and SE of 3 determinations
2. Means and SE of 2 determinations
3. Means and SE of 7 groundnut cultivars

digestion tube for nitrogen determination. Nitrogen content was determined by the Technicon auto analyzer method as described earlier.

3.0 RESULTS AND DISCUSSION

ICGS 11, ICGS 44, and Kadiri 3, had a comparatively higher digestibility among all the cultivars, while ICGS 5 showed the lowest digestibility of 84.1% (Table 43).

When the IVPD and rat bioassay data are compared, ICGS 5 showed the lowest digestibility in both the *in vivo* and *in vitro* studies. ICGS 21 showed the highest digestibility of 99.0% in *in vivo* while it was ranked 5th out of 7 cultivars in the rat bioassay procedure. The true digestibility values were comparatively higher in *in vivo* or biological evaluation studies than in *in vitro* digestion. The digestibility values ranged from 95.4% to 99.0% in the in vivo studies with a mean of 96.9%, whereas the IVPD values ranged from 84.1% to 86.5% with a mean of 85.6%. One reason for the increased digestibility by the *in vivo* could be due to the activity of the micro flora in the intestines of rats.

Reference

Axtell, J.D., Kirleis, A.W., Hassan, M.M., Mason N. D'craz, Mertz, E.T., and Munck, L. 1981. Digestibility of sorghum proteins. Proceedings of National Academy of Sciences, USA 78:1333 - 1335.

SECTION IX : COLLABORATION WITH ICRISAT REGIONAL CENTER AND NATIONAL AGRICULTURAL RESEARCH SYSTEMS

COLLABORATION WITH ICRISAT REGIONAL CENTER AND NATIONAL AGRICULTURAL RESEARCH SYSTEMS

A. Collaboration with ICRISAT Regional Groundnut Improvement Program, Malawi

Dr. G.L. Hildebrand, Groundnut Breeder, ICRISAT Regional Groundnut Improvement Program for Southern Africa, Malawi approached us for assistance in conducting fatty acid analyses on groundnut samples. According to him, there was an urgent need to screen germplasm accessions for their stability as chalimbana, a variety that was usually exported to Europe for confectionery purpose posed some problems with regard to its blanching quality. Therefore, most of the promising lines in the Malawi Regional Program, as well as some of the lines and varieties that were currently being used in breeding programs in the Region, were analyzed for their fatty acid composition at ICRISAT Center. Groundnut cultivars were cleared through the necessary quarantine regulations and sixty cultivars thus received were analyzed for their fatty acid composition. Oleic to linoleic acid ratio of 1.6 is the reported minimum value sought by the buyers. Data obtained on these 60 groundnut cultivars are shown in Table 44.

B. Collaboration with National Agricultural Research Systems (NARS's)

In association with the Resource Management Program at ICRISAT, we collaborated with the Ministry of Agriculture, Department of Rural Development, Directorate of Marketing and

Table 44. Fatty acid composition of groundnut cultivars received from Malawi

Serial number	Identification number	Laboratory number	Palmitic 16:0	Stearic 18.0	Oleic (O) 18:1	Linoleic(L) 18:2	Arachidic 20:0	Eicosenoic 20:1	Behenic 22:0	Lignoceric 24:0	O/L ratio
			(%)								
1	GNB/CNT 1	1261	9.9	2.5	47.3	31.8	1.5	1.5	3.1	1.9	1.49
2	GNB/CNT 2	1262	10.2	3.3	46.4	32.1	1.7	1.2	3.0	1.8	1.45
3	GNB/CNT 3	1263	10.1	3.2	48.1	31.3	1.5	1.2	2.6	1.5	1.54
4	GNB/CNT 4	1264	10.2	3.3	46.2	32.0	1.6	1.4	3.1	1.8	1.45
5	GNB/CNT 5	1265	10.8	3.6	40.5	36.8	1.7	1.3	3.0	1.8	1.11
6	GNB/CNT 6	1266	10.5	2.9	46.3	33.3	1.5	1.1	2.7	1.4	1.40
7	GNB/CNT 7	1267	11.0	4.4	42.1	34.2	2.0	1.0	3.3	1.6	1.23
8	GNB/CNT 8	1268	10.5	2.6	47.3	32.2	1.4	1.2	2.8	1.6	1.47
9	GNB/CNT 9	1269	10.6	2.6	46.0	33.0	1.4	1.3	2.8	1.7	1.40
10	GNB/CNT 10	1270	11.6	5.7	40.4	32.8	2.4	0.9	4.3	1.5	1.24
11	GNB/CNT 11	1271	9.3	4.0	52.6	26.0	1.8	1.1	3.0	1.6	2.03
12	GNB/CNT 12	1272	10.2	2.7	46.5	33.1	1.4	1.3	2.6	1.7	1.41
13	GNB/CNT 13	1273	10.4	3.3	45.8	32.6	1.6	1.3	2.8	1.8	1.41
14	GNB/CNT 14	1274	9.4	3.7	50.8	28.0	1.8	1.2	3.1	1.7	1.82
15	GNB/CNT 15	1275	9.5	2.4	48.7	31.6	1.3	1.5	2.8	1.8	1.55
16	GNB/CNT 16	1276	10.1	4.1	47.4	30.6	1.8	1.1	3.0	1.5	1.56
17	GNB/CNT 17	1277	9.7	2.5	47.4	32.5	1.3	1.5	2.8	1.7	1.46
18	GNB/CNT 18	1278	10.3	2.8	46.6	32.0	1.5	1.3	3.0	1.9	1.46
19	GNB/CNT 19	1279	10.8	2.4	46.3	32.0	1.4	1.5	3.1	2.0	1.45
20	GNB/CNT 20	1280	9.9	2.7	47.5	31.3	1.5	1.5	3.2	1.9	1.52
21	GNB/CNT 21	1281	10.2	3.0	47.5	31.0	1.6	1.3	3.1	1.8	1.54
22	GNB/CNT 22	1282	10.1	3.3	45.6	33.1	1.6	1.3	2.7	1.9	1.38

Serial number	Identification number	Laboratory number	Palmitic 16:0	Stearic 18:0	Oleic (O) 18:1	Linoleic (L) 18:2	Arachidic 20:0	Eicosenoic 20:1	Behenic 22:0	Lignoceric 24:0	O/L ratio
						(%)					
23	GNB/CNT 23	1283	9.8	2.3	47.4	32.6	1.3	1.3	2.9	1.8	1.46
24	GNB/CNT 24	1284	9.6	3.6	51.9	27.0	1.7	1.2	3.0	1.6	1.93
25	GNB/CNT 25	1285	11.3	4.6	39.6	36.0	2.0	0.9	3.6	1.6	1.10
26	GNB/CNT 26	1286	10.4	3.1	46.8	32.0	1.6	1.2	2.9	1.6	1.47
27	GNB/CNT 27	1287	9.7	2.3	48.1	32.0	1.3	1.3	3.0	1.7	1.51
28	GNB/CNT 28	1288	10.1	3.8	49.0	30.0	1.7	1.0	2.7	1.4	1.64
29	GNB/CNT 29	1289	10.1	3.0	45.6	32.4	1.6	1.6	3.2	2.1	1.41
30	GNB/CNT 30	1290	10.3	3.4	50.8	28.3	1.6	1.1	2.9	1.6	1.80
31	GNB/CNT 31	1291	10.0	2.9	44.9	33.4	1.5	1.5	3.2	2.0	1.35
32	GNB/CNT 32	1292	10.7	2.4	48.1	31.9	1.3	1.2	2.5	1.6	1.51
33	GNB/CNT 33	1293	10.4	2.8	45.0	33.4	1.5	1.5	3.0	1.9	1.35
34	GNB/CNT 34	1294	10.0	3.1	48.3	30.6	1.6	1.3	2.9	1.8	1.58
35	GNB/CNT 35	1295	10.2	3.5	45.7	32.4	1.7	1.6	2.9	1.7	1.41
36	GNB/CN 36	1296	10.4	4.6	45.5	30.9	2.0	1.0	3.4	1.6	1.48
37	GNB/CNT 37	1297	10.5	3.1	47.7	31.9	1.5	1.0	2.7	1.4	1.50
38	GNB/CNT 38	1298	10.4	3.1	48.5	31.0	1.5	1.1	2.5	1.5	1.57
39	GNB/CNT 39	1299	10.6	3.0	49.5	30.4	1.4	1.1	2.3	1.3	1.64
40	GNB/CNT 40	1300	10.8	3.2	47.4	31.6	1.6	1.1	2.6	1.4	1.50
41	GNB/CNT 41	1301	10.3	4.0	50.0	26.9	1.9	1.2	3.7	1.6	1.86
42	GNB/CNT 42	1302	9.7	3.0	48.8	30.9	1.5	1.3	2.8	1.6	1.58
43	GNB/CNT 43	1303	10.6	2.4	48.2	31.2	1.5	1.1	2.6	1.5	1.55
44	ICGM 284	1304	12.9	3.6	39.3	35.3	1.8	1.1	3.9	1.7	1.12

Serial number	Identification number	Laboratory number	Palmitic 16:0	Stearic 18:0	Oleic (O) 18:1	Linoleic(L) 18:2	Arachidic 20:0	Eicosenoic 20:1	Behenic 22:0	Lignoceric 24:0	O/L ratio
							(%)				
45	ICGM 484	1305	10.5	3.1	46.0	32.6	1.7	1.1	3.2	1.3	1.42
46	ICGM 741	1306	9.2	1.5	51.1	29.3	1.1	2.0	2.9	2.2	1.74
47	ICGM 742	1307	10.0	2.0	43.7	35.8	1.3	1.7	3.0	1.9	1.23
48	ICGMS 30	1308	13.9	2.2	38.9	37.6	1.2	1.4	2.9	1.5	1.04
49	ICGMS31	1309	11.3	3.3	40.3	36.1	1.8	1.2	3.8	1.9	1.12
50	ICGMS 42	1310	9.5	3.6	52.2	26.5	1.8	1.2	3.4	1.4	1.97
51	ICGMS 50	1311	9.5	4.3	52.9	25.7	1.9	1.0	3.1	1.3	2.06
52	ICGMS 52	1312	9.9	2.8	52.4	27.0	1.4	1.4	3.1	1.5	1.94
53	ICGMS 63	1313	10.9	4.9	48.6	27.3	2.1	1.0	3.7	1.3	1.78
54	M 13	1314	9.5	2.3	49.1	30.6	1.3	1.7	3.3	1.7	1.61
55	MUKULU RED	1315	9.1	2.6	45.6	33.2	1.5	1.7	3.2	2.4	1.38
56	MANI PINTAR	1316	8.9	3.2	47.8	30.2	1.7	1.7	3.6	2.1	1.59
57	FLAMINGO	1317	10.7	3.8	48.4	29.4	1.8	1.0	3.1	1.4	1.65
58	RG 1	1318	9.8	2.2	46.6	32.3	1.4	1.7	3.4	2.0	1.45
59	RMP 40	1319	9.9	2.3	46.0	31.8	1.4	1.6	3.3	2.2	1.48
60	SPANCROSS	1320	11.7	4.8	41.1	33.1	2.2	1.0	4.1	1.7	1.25

Inspection, Faridabad 121 001, Uttar Pradesh, India, in a project entitled "Efficiency of marketing of semi-arid crops in India." The purpose was to relate market price with grain quality characteristics. One crop that was selected for this purpose was groundnut. Groundnut kernels were collected from different market yards in various districts of Andhra Pradesh, Gujarat, Karnataka, Kerala, Maharashtra, Orissa, and Tamil Nadu States by the staff of Directorate of Marketing and Inspection along with other details. They were analyzed for their oil and protein contents in the Regional Agmark Laboratory, New Delhi, India and also at ICRISAT. We analyzed 495 groundnut samples received from this survey. The oil content in these samples varied from 38.8% to 54.9% and protein content from 15.1% to 33.3%.

SECTION X. INFLUENCE OF LOCATION AND ENVIRONMENT ON PROTEIN CONTENT, OIL CONTENT, AND OIL QUALITY

INFLUENCE OF LOCATION AND ENVIRONMENT ON PROTEIN CONTENT, OIL CONTENT, AND OIL QUALITY

Note : This section contains data obtained in our laboratory on several breeders' trials. Data have not been analyzed statistically as some of the experiments have not been completed. We have reported the data here mainly for convenience of retrieval and to have an idea of the variability in these grain constituents. Data reported in this section consists of three sub sections A, B and C.

A. Selection of germplasm accessions for quality studies trial (QST)

We selected germplasm accessions having high and low oil contents and high and low protein contents from the data reported in our earlier Progress Reports (1/86 and 4/87). Thirteen accessions were identified and grown in 3 replications at ICRISAT Center, Hisar and Dharwad locations in rainy season 1988, and at ICRISAT Center and Bhavanisagar locations in postrainy season 1988/89. Data obtained on protein content, oil content, fatty acid composition and oleic to linoleic acid (O/L) ratio on these 13 accessions are given in Appendix-I.

B. Evaluation of various trials for quality parameters

It is important to have an understanding of the stability of various grain quality characteristics across locations and environments. As part of our ongoing exercise, we have analyzed

Table 45. Groundnut cultivars belonging to the following trials and grown in the season, year, and location as indicated were analyzed for their quality characteristics

Trial	No. of entries	Season	Year	Location	Data given in Appendix I (Page No.)
ECGVT	25	R	1987	IC	
ECGVT	25	R	1987	IC	
ECGVT	25	R	1987	Hisar	
ECGVT	23	R	1987	Dharwad	
ECGVT	25	R	1987	Bhavanisagar	
ECGVT	25	PR	1987/88	IC	
ECGVT	25	PR	1987/88	Bhavanisagar	
USCL	48	PR	1987/88	IC	
PCGVT-1	55	PR	1987/88	IC	
PCGVT	64	R	1988	IC	
PCGVT-1	64	R	1988	IC	
PCGVT-2	30	R	1988	IC	
PCGVT-2	30	R	1988	IC	
QST	39	R	1988	IC	
QST	39	R	1988	Hisar	
QST	39	R	1988	Dharwad	
ICGV	196	PR	1988/89	IC	
QST	78	PR	1988/89	IC	
ICGV	37	PR	1988/89	Bhavanisagar	
QST	39	PR	1988/89	Bhavanisagar	
Total	931				

ECGVT : Elite Confectionary Groundnut Varietal Trial
USCL : US Confectionery Lines
PCGVT : Preliminary Confectionery Groundnut Varietal Trial
QST : Quality Studies Trial
ICGV : ICRISAT Confectionery Groundnut Varieties
R : Rainy
PR : Postrainy
IC : ICRISAT Center

groundnut cultivars for their oil, protein, and fatty acid composition. Details of the trials, number of samples, season, year grown, and locations are described in Table 45. Data obtained on individual cultivars from a particular location, season and year are given in Appendix I.

C. APPENDIX I

Protein content, oil content and oil quality of groundnut cultivars grown across different seasons and locations

Breeder No	Lab No	Protein	Oil	Palmitic 16:0	Stearic 18:0	Oleic (O) 18:1	Linoleic(L) 18:2	Arachidic 20:0	Eicosenoic 20:1	Behenic 22:0	Lignoceric 24:0	O/L Ratio
						(%)						
Elite Confectionery Groundnut Varietal Trial, BIL 6, ICRISAT Center, Rainy Season 1987												
1	19393	22.50	45.70	10.99	3.62	47.98	27.19	1.99	1.15	4.63	1.95	1.77
2	19394	21.30	48.50	11.61	2.28	47.68	29.42	1.40	1.41	3.29	2.12	1.62
3	19395	21.70	49.20	12.55	2.40	39.03	37.09	1.44	1.36	3.62	2.03	1.06
4	19396	23.30	47.80	11.55	3.09	49.41	28.23	1.55	1.10	3.10	1.60	1.76
5	19397	25.90	44.60	12.76	2.84	41.25	33.50	1.70	1.24	3.90	2.09	1.24
6	19398	25.70	47.70	12.93	2.10	38.35	36.27	1.40	1.55	4.13	2.52	1.06
7	19399	22.30	47.00	13.14	2.03	37.65	36.16	1.39	1.64	4.56	2.64	1.05
8	19400	23.70	46.10	12.52	2.01	40.57	34.81	1.34	1.51	3.96	2.50	1.17
9	19401	24.00	48.00	12.63	2.01	40.64	34.34	1.37	1.60	4.07	2.54	1.17
10	19402	24.40	45.90	12.99	2.00	37.86	35.92	1.39	1.69	4.48	2.79	1.06
11	19403	20.40	50.00	13.06	2.58	40.36	34.49	1.50	1.32	3.75	2.21	1.17
12	19404	24.90	48.10	12.82	2.89	40.69	34.33	1.77	1.14	3.67	1.98	1.19
13	19405	24.10	47.70	13.33	2.82	40.57	33.11	1.72	1.23	3.92	2.34	1.23
14	19406	22.20	49.10	12.65	2.14	36.73	38.44	1.42	1.47	3.68	2.59	0.96
15	19407	19.00	51.70	13.03	2.62	40.33	34.57	1.52	1.32	3.65	2.24	1.17
16	19408	24.00	49.10	13.12	3.08	40.20	34.13	1.87	1.11	3.79	2.02	1.10
17	19409	24.00	51.10	11.37	3.09	47.36	29.48	1.72	1.15	3.48	1.71	1.61
18	19410	19.60	49.70	12.63	2.68	40.42	35.49	1.54	1.27	3.52	1.95	1.14
19	19411	24.20	48.20	13.32	2.89	38.67	35.93	1.76	1.14	3.59	2.01	1.08
20	19412	22.90	46.90	10.87	2.25	50.67	27.10	1.38	1.56	3.63	2.11	1.88
21	19413	23.20	45.60	11.69	2.16	47.31	29.28	1.38	1.57	3.73	2.20	1.62

Breeder No	[illegible] No	[illegible] kg/ha	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Behenic 22.0	Lignoceric 24.0	O/L Ratio
22	19414	22.80	47.50	13.43	2.99	37.35	37.74	1.33	1.57	3.93	2.50	1.01
23	19415	26.20	46.60	13.83	3.52	38.44	35.79	1.29	1.02	3.65	1.90	1.10
24	19416	24.00	46.00	13.37	2.89	37.38	37.91	1.35	1.50	3.87	2.42	1.01
25	19417	21.90	45.70	13.31	3.04	36.35	38.13	1.32	1.60	4.05	2.57	0.96

Elite Confectionery Groundnut Varietal Trial, RP 5, ICRISAT Center, Rainy Season 1987

1	19418	23.70	48.20	12.92	4.14	52.11	29.55	2.09	1.00	4.23	1.54	2.07
2	19419	22.00	49.70	13.17	2.69	37.44	34.26	1.49	1.25	2.97	1.85	1.97
3	19420	21.30	47.50	12.63	2.69	40.39	35.45	1.49	1.28	3.36	1.86	1.15
4	19421	24.60	43.30	11.74	3.24	51.78	24.15	1.61	1.06	3.12	1.51	1.94
5	19422	26.00	45.00	12.85	2.96	44.75	29.19	1.81	1.24	4.13	2.36	1.53
6	19423	24.80	47.90	13.11	2.51	40.28	34.54	1.43	1.40	3.76	2.17	1.17
7	19424	22.80	47.10	12.55	2.41	42.76	33.86	1.39	1.24	3.15	2.05	1.27
8	19425	23.50	47.90	13.14	2.23	39.27	35.51	1.44	1.42	3.81	2.35	1.11
9	19426	23.30	47.50	13.13	2.11	39.23	34.79	1.42	1.44	3.90	2.56	1.13
10	19427	23.80	48.30	13.34	2.18	38.83	35.42	1.44	1.45	3.89	2.52	1.10
11	19428	19.80	47.70	12.74	2.71	41.14	35.04	1.51	1.25	3.32	1.85	1.18
12	19429	26.30	44.90	12.86	2.97	43.55	31.54	1.75	1.15	3.89	2.10	1.41
13	19430	25.30	44.20	13.39	2.82	40.59	33.91	1.71	1.25	3.90	2.00	1.20
14	19431	22.70	47.20	12.56	2.25	37.43	38.11	1.45	1.49	3.49	2.33	0.99
15	19432	20.30	48.50	12.79	2.73	40.91	35.29	1.50	1.25	3.32	1.75	1.16
16	19433	25.30	42.90	13.02	2.94	42.79	31.21	1.79	1.22	3.96	2.20	1.38
17	19434	23.00	48.70	12.87	3.08	49.70	27.26	1.67	1.08	3.51	1.57	1.83
18	19435	19.50	48.00	12.94	2.84	42.33	33.31	1.52	1.17	3.37	1.89	1.28

Breeder No	Lab No	Protein	Oil	Palmitic 16:0	Stearic 18:0	Oleic (O) 18:1	Linoleic(L) 18:2	Arachidic 20:0	Eicosanoic 20:1	Behenic 22:0	Lignoceric 24:0	O/L Ratio
						(%)						
19	19436	26.60	43.80	13.47	2.96	41.44	32.69	1.72	1.18	3.70	2.23	1.27
20	19437	23.10	47.20	11.03	2.77	52.26	25.82	1.39	1.27	3.20	1.77	2.03
21	19438	21.80	46.00	10.81	2.42	51.21	27.41	1.34	1.34	3.07	1.76	1.87
22	19439	21.60	46.30	13.29	2.06	38.51	36.47	1.36	1.54	3.74	2.25	1.06
23	19440	27.60	44.60	13.24	4.03	37.43	36.69	1.87	0.97	3.77	1.52	1.02
24	19441	22.60	45.90	13.05	2.10	37.76	38.03	1.38	1.47	3.65	1.99	1.00
25	19442	22.50	46.80	12.90	2.01	37.77	38.27	1.34	1.50	3.62	2.02	0.99
	Elite Confectionery Groundnut Varietal Trial, Hisar, Rainy Season 1987											
1	19832	24.60	51.30	9.89	3.11	46.50	29.48	1.97	1.51	4.95	2.11	1.58
2	19833	24.30	47.00	10.61	2.07	45.84	32.07	1.44	1.63	3.30	2.29	1.43
3	19834	22.70	49.40	11.07	1.94	36.16	39.99	1.46	1.89	4.12	2.76	0.91
4	19835	19.50	47.50	10.54	2.83	49.06	28.93	1.61	1.25	3.26	1.88	1.70
5	19836	27.70	49.00	11.83	2.53	38.70	37.70	1.61	1.27	3.49	2.01	1.03
6	19837	24.00	50.40	11.20	1.82	36.17	40.79	1.36	1.70	3.96	2.30	0.89
7	19838	23.80	46.80	10.73	1.72	39.59	37.36	1.36	1.96	3.81	2.81	1.06
8	19839	23.30	52.00	11.11	1.77	35.82	40.94	1.41	1.79	3.88	2.60	0.88
9	19840	20.40	46.80	11.12	1.83	36.16	40.11	1.41	1.94	4.20	2.57	0.91
10	19841	24.80	49.70	10.71	2.04	36.92	39.63	1.50	1.85	4.05	2.66	0.94
11	19842	21.50	48.80	11.24	1.94	36.78	39.88	1.39	1.56	3.84	2.66	0.93
12	19843	27.50	48.80	11.92	2.85	38.90	36.62	1.81	1.27	3.38	2.32	1.07
13	19844	27.70	47.50	11.98	2.28	35.75	39.60	1.63	1.59	3.68	2.56	0.91
14	19845	24.40	46.30	10.98	1.77	36.62	41.88	1.35	1.82	3.63	2.99	0.83
15	19846	20.90	49.60	11.12	2.26	37.23	39.53	1.48	1.58	3.43	2.62	0.95
16	19847	25.30	48.00	11.73	2.46	37.18	37.07	2.98	2.20	3.59	2.38	1.01

Breeder No	Lab No	Pro-tein	Oil	Palmitic 16:0	Stearic 18:0	Oleic (O) 18:1	Linoleic(L) 18:2	Arachidic 20:0	Eicosenoic 20:1	Behenic 22:0	Lignoceric 24:0	O/L Ratio
						(%)						
17	19848	27.50	47.70	11.91	2.46	34.91	42.80	0.67	0.84	3.86	2.31	0.82
18	19849	23.60	49.90	11.01	1.73	34.58	44.30	0.43	1.17	3.30	2.59	0.78
19	19850	28.20	47.60	11.84	2.77	37.24	40.70	0.76	0.80	3.28	2.31	0.92
20	19851	21.40	43.00	10.06	2.18	46.44	30.95	1.41	1.94	3.86	2.30	1.50
21	19852	24.60	47.10	10.05	2.01	48.45	29.73	1.32	1.77	3.68	2.33	1.63
22	19853	25.20	50.10	11.94	1.77	36.46	39.97	1.36	1.70	3.62	2.54	0.92
23	19854	24.40	51.70	10.64	2.64	45.53	32.49	1.57	1.22	3.38	2.02	1.41
24	19855	24.40	50.30	11.87	1.81	36.41	39.81	1.37	1.65	3.56	2.62	0.92
25	19856	25.20	50.10	11.84	1.70	36.10	40.18	1.28	1.70	3.50	2.72	0.90
	Elite Confectionery Groundnut Varietal Trial, Dharwar, Rainy Season 1987											
1	19857	19.80	47.60	10.59	4.38	48.34	26.55	2.11	1.10	4.44	1.96	1.82
2	19858	20.60	45.70	11.64	2.81	49.23	28.41	1.44	1.15	2.92	1.94	1.74
3	19859	22.00	44.00	12.44	2.13	38.07	39.44	0.51	0.99	3.87	2.33	0.97
4	19860	23.70	41.00	11.40	4.12	48.49	27.38	1.79	1.04	3.38	1.72	1.78
5	19861	27.20	44.60	12.44	2.95	40.25	36.95	0.79	0.77	3.51	2.11	1.09
6	19862	22.10	41.10	11.68	1.97	36.94	39.47	0.65	1.26	4.35	2.32	0.94
7	19863	22.00	43.80	12.07	2.01	39.95	38.13	0.54	1.03	3.61	2.37	1.05
8	19864	22.00	45.00	12.56	2.07	37.69	39.15	0.65	1.17	4.06	2.31	0.97
9	19865	23.20	46.20	12.50	2.13	38.83	36.03	2.20	1.83	3.95	2.24	1.08
10	19866	23.60	43.70	12.49	2.04	38.02	38.70	0.66	1.22	4.20	2.34	0.99
11	19867	19.70	44.60	12.57	2.36	39.56	35.71	2.07	1.82	3.61	2.01	1.11
12	19868	25.20	45.50	12.27	3.17	42.00	31.59	2.87	1.87	3.76	2.21	1.33
13	19869	27.90	44.50	13.24	2.64	40.42	33.56	2.24	1.50	3.76	2.38	1.21

Breeder No	Lab No	Protein	Oil	Palmitic 16:0	Stearic 18:0	Oleic (O) 18:1	Linoleic(L) 18:2	Arachidic 20:0	Eicosenoic 20:1	Behenic 22:0	Lignoceric 24:0	O/L Ratio
						(%)						
14	19870	20.60	46.80	12.30	2.22	35.73	39.37	2.03	1.76	3.21	2.78	0.91
15	19871	18.90	47.20	12.22	2.12	37.52	40.20	0.50	0.94	3.91	2.36	0.94
16	19872	26.70	44.00	12.89	2.78	40.44	33.55	2.40	1.64	3.76	2.26	1.21
17	19873	22.70	46.50	11.34	2.92	46.65	28.92	2.25	1.52	4.07	2.10	1.62
18	19874	23.00	48.70	11.18	2.38	35.91	39.13	2.40	2.24	3.56	2.69	0.92
19	19875	26.30	43.30	13.27	3.38	39.86	33.93	2.25	1.26	3.71	2.04	1.18
20	19876	20.30	46.40	11.36	2.42	48.60	29.11	1.32	1.40	3.38	1.91	1.67
21	19877	18.70	45.70	11.74	2.65	47.91	29.25	1.37	1.35	3.27	1.95	1.64
22	19878	22.00	43.40	12.93	2.04	37.37	38.14	1.26	1.45	3.51	2.67	0.98
23	19879	28.40	41.80	13.34	3.50	36.34	37.65	1.70	1.03	3.79	1.89	0.97

Elite Confectionery Groundnut Varietal Trial, Bhavanisagar, Rainy Season 1987

1	19882	25.00	51.60	9.15	5.63	55.26	20.31	2.58	0.85	4.18	1.66	2.72
2	19883	28.70	48.30	10.14	2.87	55.65	23.00	1.58	1.23	3.01	1.91	2.42
3	19884	26.00	50.90	12.14	2.76	42.33	32.59	1.72	1.42	3.65	2.34	1.30
4	19885	26.40	46.40	10.07	5.21	55.17	23.25	1.69	1.17	2.91	1.68	2.37
5	19886	29.50	49.90	11.84	3.49	48.76	26.68	1.88	1.13	3.17	2.00	1.83
6	19887	28.70	49.80	12.30	2.51	42.48	33.38	1.50	1.26	3.47	2.28	1.28
7	19888	25.60	51.00	11.66	2.44	43.22	34.35	1.47	1.18	2.96	2.01	1.26
8	19889	27.80	50.00	12.11	2.23	41.99	34.85	1.41	1.28	3.11	2.19	1.21
9	19890	26.90	52.20	12.16	2.29	42.85	32.93	1.50	1.43	3.75	2.34	1.30
10	19891	27.10	50.80	12.07	2.26	42.31	33.36	1.53	1.50	3.73	2.41	1.27
11	19892	27.90	52.10	12.16	3.22	43.34	32.54	1.73	1.14	3.12	2.04	1.33
12	19893	30.20	49.80	11.61	3.30	48.26	28.29	1.78	1.06	2.95	1.96	1.71

Breeder No	Lab No	Protein	Oil	Palmitic 16:0	Stearic 18:0	Oleic (O) 18:1	Linoleic(L) 18:2	Arachidic 20:0	Eicosenoic 20:1	Behenic 22:0	Lignoceric 24:0	O/L Ratio
						(%)						
13	19894	31.00	50.20	12.65	3.18	45.65	29.41	1.82	1.08	3.22	2.12	1.55
14	19895	27.00	50.00	11.82	2.65	40.59	35.09	1.63	1.33	3.30	2.47	1.16
15	19896	26.40	51.70	11.91	3.27	41.94	34.12	1.70	1.02	2.94	1.97	1.23
16	19897	30.50	48.90	12.90	3.19	42.09	32.98	1.79	1.05	3.12	2.17	1.28
17	19898	27.30	50.50	10.32	3.67	52.48	24.74	1.91	1.05	3.30	1.80	2.12
18	19899	25.40	50.40	11.75	3.43	41.86	30.91	1.87	1.08	3.31	2.08	1.46
19	19900	31.00	48.50	13.37	3.59	41.19	31.08	1.83	1.03	2.91	2.25	1.39
20	19901	29.40	51.40	11.77	3.25	51.04	25.40	1.73	1.11	3.10	2.13	2.09
21	19902	26.30	47.60	9.91	2.89	57.83	21.08	1.48	1.28	2.94	1.84	2.74
22	19903	26.10	49.60	12.63	2.48	42.37	33.96	1.47	1.21	2.90	2.24	1.25
23	19904	29.30	47.60	13.11	3.15	39.74	35.60	1.62	0.93	3.16	2.05	1.12
24	19905	26.90	48.90	12.15	2.69	43.30	32.61	1.49	1.25	3.27	2.15	1.33
25	19906	24.80	48.70	12.54	2.26	40.42	35.86	1.41	1.29	3.15	2.24	1.14
Elite Confectionery Groundnut Varietal Trial, Vertisol, ICRISAT Center, Postrainy Season 1987/88												
1	21897	23.10	51.70	10.21	3.81	49.10	28.11	2.56	1.37	3.50	1.98	1.75
2	21898	22.00	49.50	10.12	2.73	50.35	28.46	2.14	1.46	3.06	1.49	1.77
3	21899	24.30	51.90	11.59	2.59	38.99	38.48	2.15	1.43	2.84	1.42	1.02
4	21900	25.80	45.50	10.19	2.93	51.38	27.69	2.60	1.47	2.43	1.07	1.86
5	21901	27.10	48.20	12.18	3.26	42.18	34.16	2.17	1.16	3.02	1.55	1.24
6	21902	25.20	51.00	11.52	2.32	39.40	37.55	2.29	1.81	3.06	1.66	1.05
7	21903	24.50	49.90	10.88	2.17	41.98	36.50	1.98	1.55	2.73	1.67	1.15
8	21904	25.20	51.60	11.27	2.21	39.00	38.28	1.95	1.63	3.41	1.72	1.02
9	21905	25.00	48.40	12.19	2.44	37.74	41.38	0.67	0.92	2.76	1.46	0.92

Breeder No	Lab No	Protein	Oil	Palmitic 16:0	Stearic 18:0	Oleic (O) 18:1	Linoleic(L) 18:2	Arachidic 20:0	Eicosenoic 20:1	Behenic 22.0	Lignoceric 24:0	O/L Ratio
						(%)						
10	21906	25.30	51.10	11.44	2.07	37.64	39.36	2.11	1.73	3.51	1.74	0.96
11	21907	24.40	51.20	11.63	2.65	37.19	42.57	0.61	0.76	2.77	1.49	0.88
12	21908	28.10	47.60	12.43	2.90	41.05	35.21	2.09	1.27	2.94	1.68	1.17
13	21909	26.90	48.70	12.95	3.06	38.21	36.82	2.88	1.50	2.96	1.42	1.04
14	21910	23.70	50.00	11.49	2.04	34.35	43.03	1.91	1.76	3.00	1.77	0.80
15	21911	26.00	52.70	11.70	2.84	39.17	37.98	2.23	1.39	2.73	1.50	1.04
16	21912	27.00	48.40	12.19	3.32	40.90	34.24	2.78	1.68	3.04	1.59	1.20
17	21913	25.80	51.00	9.76	3.17	47.64	29.12	3.38	2.10	3.30	1.36	1.64
18	21914	21.10	49.30	11.82	2.67	38.38	38.90	1.91	1.37	2.86	1.59	0.99
19	21915	27.50	46.70	12.98	3.00	38.31	36.53	2.79	1.68	2.83	1.60	1.05
20	21916	27.90	48.70	10.32	2.61	49.02	29.65	2.08	1.80	2.79	1.42	1.66
21	21917	25.70	47.30	9.69	2.62	51.80	27.43	1.86	1.54	2.95	1.60	1.89
22	21918	24.20	48.30	12.06	2.30	37.54	38.94	1.79	1.52	2.89	1.55	0.95
23	21919	28.20	46.50	11.79	2.88	38.20	40.90	0.62	0.59	3.53	1.32	0.94
24	21920	24.80	47.70	12.02	2.18	36.94	40.33	1.91	1.55	2.88	1.68	0.92
25	21921	24.20	48.90	12.14	2.00	35.83	41.40	1.79	1.63	2.95	1.68	0.87

Elite Confectionery Groundnut Varietal Trial, Bhavanisagar, Postrainy Season 1987/88

1	21922	24.20	50.40	8.95	6.37	57.40	18.27	2.67	0.81	3.53	1.45	3.14
2	21923	25.00	48.60	10.14	2.68	56.20	22.60	1.50	1.23	2.70	1.83	2.49
3	21924	24.90	48.20	12.84	3.04	44.33	31.60	1.57	1.09	3.01	1.84	1.40
4	21925	26.80	48.60	10.55	3.35	58.55	20.53	1.59	0.97	2.36	1.39	2.85
5	21926	27.90	49.20	11.50	3.67	51.41	24.59	1.80	1.07	2.97	1.88	2.09
6	21927	23.70	47.30	12.74	2.75	42.96	32.97	1.53	1.18	3.31	1.87	1.30

Breeder No	Lab No	Protein	Oil	Palmitic 16:0	Stearic 18:0	Oleic (O) 18:1	Linoleic (L) 18:2	Arachidic 20:0	Eicosenoic 20:1	Behenic 22:0	Lignoceric 24:0	O/L Ratio
						(%)						
7	21928	23.20	49.10	12.12	2.71	44.00	32.53	1.54	1.17	3.11	2.05	1.35
8	21929	26.10	48.50	11.99	2.59	45.70	30.86	1.53	1.28	3.17	2.09	1.48
9	21930	25.70	50.10	12.34	3.39	47.47	29.20	1.60	1.00	2.58	1.70	1.63
10	21931	26.20	49.30	12.73	2.40	43.04	33.45	1.44	1.19	2.89	2.02	1.29
11	21932	21.20	52.90	13.10	3.36	45.02	31.00	1.69	0.96	2.62	1.57	1.45
12	21933	27.10	50.60	11.56	4.06	51.75	24.31	1.93	0.98	2.79	1.77	2.13
13	21934	29.40	49.30	11.64	3.65	51.68	25.09	1.75	0.98	2.60	1.73	2.06
14	21935	24.10	48.60	12.44	3.22	39.93	36.70	1.47	1.18	2.76	2.21	1.09
15	21936	20.60	51.00	12.48	3.39	44.91	31.14	1.73	0.99	2.91	1.74	1.44
16	21937	29.10	49.30	11.75	3.76	49.80	26.39	1.90	1.04	2.74	1.70	1.89
17	21938	24.00	51.80	10.25	4.50	56.94	20.26	2.05	0.96	2.91	1.46	2.81
18	21939	22.90	53.00	12.60	3.82	47.35	28.71	1.76	0.94	2.47	1.59	1.65
19	21940	28.40	48.10	11.54	4.07	50.70	25.04	1.95	0.98	2.80	1.81	2.01
21	21941	23.70	49.70	9.43	3.25	62.33	17.55	1.51	1.15	2.61	1.57	3.55
22	21942	23.30	48.80	12.32	2.80	44.40	32.22	1.52	1.14	2.83	1.98	1.38
23	21943	27.40	47.20	13.49	4.15	43.18	31.23	1.76	0.84	3.09	1.61	1.38
24	21944	26.90	45.60	12.78	2.80	43.44	32.47	1.51	1.18	2.98	2.06	1.34
25	21945	24.80	48.60	12.72	2.60	42.62	33.32	1.53	1.25	3.07	2.09	1.28
	US Confectionery Lines, ICRISAT Center, Postrainy Season 1987/88											
1	22576	23.40	48.90	10.14	2.46	48.98	29.85	2.40	1.98	2.27	1.37	1.64
2	22577	22.60	48.70	9.52	2.78	51.85	26.99	2.57	2.02	2.70	1.30	1.93
5	22578	23.40	48.30	10.04	2.68	49.46	30.40	1.91	1.43	2.20	1.37	1.63
6	22579	24.90	48.40	10.49	2.31	48.87	30.73	1.92	1.54	2.20	1.43	1.59

Breeder No	Lab No	Protein	Oil	Palmitic 16:0	Stearic 18:0	Oleic (O) 18:1	Linoleic(L) 18:2	Arachidic 20:0	Eicosenoic 20:1	Behenic 22:0	Lignoceric 24:0	O/L Ratio
						(%)						
7	22580	24.40	48.30	9.66	2.64	47.01	32.63	1.97	1.47	2.48	1.63	1.44
8	22581	24.80	49.90	10.31	2.60	47.05	30.52	2.77	2.20	2.79	1.48	1.45
9	22582	24.80	49.10	10.09	2.82	48.53	30.73	1.89	1.35	2.57	1.51	1.58
10	22583	23.70	48.80	10.48	2.91	45.34	34.19	1.88	1.18	2.25	1.36	1.33
11	22584	25.30	48.20	9.73	2.85	46.98	35.02	0.68	0.62	2.65	1.25	1.35
12	22585	25.40	48.10	9.85	2.96	47.90	31.56	1.90	1.33	2.62	1.49	1.52
14	22586	24.50	48.70	8.62	3.14	55.42	23.81	3.02	2.12	2.56	1.12	2.33
18	22587	25.40	49.10	9.66	2.72	48.69	29.23	2.89	2.17	2.89	1.48	1.67
19	22588	25.60	49.50	10.32	2.62	47.45	31.49	2.28	1.49	2.59	1.42	1.51
20	22589	26.80	46.50	10.69	2.45	45.46	33.76	1.82	1.34	2.38	1.58	1.35
21	22590	24.80	48.60	10.60	2.41	45.34	35.43	0.67	0.85	2.86	1.54	1.28
26	22591	23.20	49.90	10.24	2.57	47.81	31.48	2.12	1.47	2.46	1.39	1.52
31	22592	23.00	48.40	9.68	2.74	50.86	29.32	2.20	1.41	2.29	1.14	1.74
32	22593	23.90	46.80	10.23	2.56	50.93	29.03	1.83	1.40	2.35	1.28	1.76
33	22594	25.00	46.30	11.29	2.69	39.78	38.19	2.04	1.41	2.72	1.49	1.08
34	22595	25.10	46.30	10.32	2.24	49.36	30.28	2.04	1.58	2.37	1.36	1.63
35	22596	25.00	47.30	9.69	2.92	55.73	24.83	1.90	1.32	1.96	1.20	2.25
37	22597	24.80	48.60	8.83	2.94	56.12	25.05	1.89	1.27	2.26	1.22	2.24
38	22598	24.70	48.70	9.95	2.50	51.13	29.12	1.92	1.45	2.24	1.29	1.76
39	22599	24.70	50.00	9.77	2.84	48.35	29.66	2.87	1.99	2.81	1.44	1.63
40	22600	23.60	49.40	10.08	2.33	50.29	29.18	2.20	1.87	2.18	1.37	1.73
41	22601	25.30	51.00	10.07	2.06	46.70	35.26	0.54	0.90	2.35	1.59	1.33
44	22602	26.90	48.50	10.04	2.86	48.32	30.30	2.41	1.54	2.73	1.47	1.60
46	22603	26.70	47.90	10.62	2.66	40.29	36.34	2.64	1.90	3.37	1.41	1.11

Breeder No	Lab No	Protein	Oil	Palmitic 16:0	Stearic 18:0	Oleic (O) 18:1	Linoleic(L) 18:2	Arachidic 20:0	Eicosenoic 20:1	Behenic 22:0	Lignoceric 24:0	O/L Ratio
						(%)						
47	22604	26.80	47.50	10.37	2.68	46.00	32.84	2.08	1.41	2.47	1.58	1.40
48	22605	25.10	46.50	11.19	2.95	46.55	32.48	1.82	1.14	2.25	1.25	1.44
49	22606	24.20	48.30	10.80	2.36	39.52	41.61	0.57	0.78	2.61	1.44	0.95
50	22607	21.60	47.60	9.46	3.04	53.42	26.97	1.95	1.25	2.43	1.14	1.98
51	22608	27.00	46.70	10.06	2.76	46.18	32.81	2.48	1.57	2.47	1.37	1.41
53	22609	26.30	48.30	9.01	3.23	56.12	24.14	2.17	1.35	2.46	1.15	2.33
54	22610	27.40	43.80	12.23	3.35	35.76	40.73	2.29	1.18	2.64	1.51	0.88
57	22611	26.40	50.80	10.16	2.67	46.95	32.47	1.92	1.36	2.54	1.47	1.45
58	22612	25.50	45.60	10.19	2.95	50.70	28.87	1.84	1.34	2.30	1.37	1.76
61	22613	25.70	48.80	9.62	2.45	49.76	29.03	2.69	2.27	2.46	1.43	1.72
62	22614	26.90	48.30	10.09	2.87	48.60	30.79	1.88	1.33	2.46	1.47	1.58
64	22615	23.80	49.30	10.59	2.39	44.70	33.99	2.03	1.51	2.67	1.58	1.32
65	22616	26.40	48.50	9.77	2.85	47.95	30.13	2.75	2.08	2.56	1.56	1.60
67	22617	25.50	45.60	9.68	2.05	49.74	32.96	0.56	0.97	2.25	1.42	1.51
68	22618	24.70	44.40	10.76	2.74	44.28	34.86	2.06	1.57	2.24	1.28	1.27
69	22619	26.70	46.50	10.06	2.46	45.43	33.53	1.94	1.47	2.43	1.63	1.37
72	22620	26.20	47.50	10.07	2.85	46.90	32.64	1.85	1.33	2.44	1.44	1.44
73	22621	25.40	47.70	9.76	2.55	47.95	38.55	1.90	1.36	2.33	1.20	1.09
74	22622	25.10	47.70	9.84	3.12	48.55	29.80	2.13	1.51	3.11	1.32	1.63
75	22623	25.80	48.40	10.52	2.37	44.04	37.42	0.66	0.85	2.31	1.43	1.18
Preliminary Confectionery Groundnut Varietal Trial-1, ICRISAT Center, Postrainy Season 1987/88												
1	22624	23.10	48.60	11.20	2.76	43.20	37.47	0.67	0.79	2.22	1.24	1.16
2	22625	24.60	50.00	10.45	4.50	43.34	33.38	2.80	1.19	2.97	1.20	1.30

Breeder No	Lab No	Protein	Oil	Palmitic 16:0	Stearic 18:0	Oleic (O) 18:1	Linoleic(L) 18:2	Arachidic 20:0	Eicosenoic 20:1	Behenic 22:0	Lignoceric 24:0	O/L Ratio
						(%)						
3	22626	23.70	48.90	10.61	3.45	47.58	29.82	2.49	1.43	3.00	1.41	1.60
4	22627	23.70	49.10	10.26	3.46	48.90	28.96	2.16	1.32	3.02	1.54	1.69
5	22628	22.90	51.40	10.35	3.51	45.05	31.70	3.13	1.82	2.97	1.30	1.43
6	22629	24.10	51.30	10.38	3.57	45.09	32.29	2.40	1.36	3.28	1.38	1.40
7	22630	23.40	52.70	10.26	3.85	48.63	29.38	2.20	1.20	2.83	1.28	1.66
8	22631	22.90	51.7[illegible]	10.14	4.29	46.67	30.61	2.53	1.24	3.07	1.22	1.53
9	22632	24.20	50.70	10.29	3.70	46.[illegible]	31.43	2.24	1.26	3.20	1.37	1.51
10	22633	24.80	50.70	10.60	3.53	40.93	35.25	3.22	1.92	3.08	1.30	1.17
11	22634	23.60	51.70	9.36	4.75	51.18	26.13	2.85	1.26	3.15	1.17	1.96
12	22635	22.70	50.60	9.86	4.86	50.43	26.60	2.60	1.10	3.29	1.21	1.90
13	22636	23.70	50.30	10.20	3.47	48.59	29.39	2.12	1.23	3.35	1.31	1.66
14	22637	24.60	50.50	9.68	4.33	50.46	27.11	2.52	1.16	3.38	1.18	1.87
15	22638	22.90	51.00	9.71	4.57	50.24	26.88	2.58	1.18	3.49	1.19	1.87
16	22639	23.60	49.60	10.59	3.01	48.20	29.96	1.84	1.16	3.30	1.39	1.61
17	22640	24.70	49.10	9.92	3.62	49.24	28.90	2.14	1.32	3.05	1.40	1.71
18	22641	24.80	48.30	10.19	3.60	47.28	30.23	2.27	1.28	3.08	1.63	1.57
19	22642	24.10	50.60	10.43	3.85	50.88	27.38	2.26	1.15	2.66	1.18	1.86
20	22643	23.20	50.60	10.25	4.26	45.04	31.33	2.52	1.30	3.60	1.27	1.44
21	22644	22.50	52.80	9.92	3.88	44.44	33.14	2.50	1.29	3.21	1.36	1.34
22	22645	24.30	51.40	9.36	4.75	51.53	25.86	2.59	1.19	3.31	1.22	2.00
23	22646	23.20	50.70	10.29	3.41	45.78	32.15	2.14	1.36	3.01	1.45	1.43
24	22647	24.20	49.30	9.76	3.67	50.44	27.69	2.21	1.28	3.35	1.39	1.83
25	22648	26.50	49.00	11.71	2.34	39.59	38.25	1.88	1.48	2.48	1.73	1.04
26	22649	25.40	49.20	9.60	3.88	50.32	27.81	2.35	1.27	3.20	1.33	1.81

Breeder No	Lab No	Protein	Oil	Palmitic 16:0	Stearic 18:0	Oleic (O) 18:1	Linoleic(L) 18:2	Arachidic 20:0	Eicosenoic 20:1	Behenic 22:0	Lignoceric 24:0	O/L Ratio
						(%)						
27	22650	24.40	50.80	9.85	4.61	48.95	27.93	2.62	1.11	3.41	1.32	1.76
28	22651	24.00	51.50	9.79	4.24	50.53	27.10	2.25	1.00	3.62	1.27	1.87
29	22652	23.30	49.90	10.10	3.90	48.55	28.23	2.98	1.83	3.09	1.16	1.72
30	22653	24.70	51.80	12.29	3.23	39.73	36.16	2.22	1.22	3.20	1.65	1.10
31	22654	25.30	47.50	10.15	3.63	48.21	29.61	2.16	1.26	3.08	1.48	1.63
32	22655	24.40	51.10	9.65	4.31	51.41	25.80	2.37	1.14	3.73	1.38	2.00
33	22656	25.00	50.70	12.04	3.66	40.68	34.96	2.39	1.20	3.12	1.66	1.17
34	22657	23.90	51.50	9.91	3.92	49.82	27.63	2.40	1.29	3.43	1.37	1.81
35	22658	23.50	50.40	9.84	3.84	48.03	28.18	3.40	2.03	3.35	1.19	1.71
36	22659	20.20	52.90	9.53	4.57	51.97	25.55	2.39	1.09	3.44	1.26	2.04
37	22660	25.30	48.80	12.07	3.55	40.96	34.69	2.25	1.23	3.22	1.70	1.18
38	22661	25.20	50.20	9.03	4.40	54.60	24.01	2.26	1.21	2.84	1.30	2.28
39	22662	22.90	50.60	10.61	4.28	45.58	31.03	2.47	1.14	3.44	1.25	1.47
40	22663	24.10	49.70	10.05	4.12	50.31	27.77	2.16	1.10	3.04	1.25	1.82
41	22664	22.10	50.80	10.01	4.33	51.02	26.74	2.23	1.16	3.10	1.22	1.91
42	22665	22.60	52.20	10.09	3.74	48.13	30.00	2.10	1.21	2.98	1.37	1.61
43	22666	22.80	51.30	9.85	2.99	50.44	28.47	1.96	1.34	3.23	1.44	1.78
44	22667	24.90	47.80	10.28	3.85	48.76	29.24	2.15	1.19	2.99	1.29	1.67
45	22668	24.90	49.80	9.91	3.80	49.54	28.88	2.16	1.15	3.08	1.28	1.72
46	22669	23.90	48.80	9.31	4.06	49.76	28.08	2.33	1.28	3.48	1.45	1.78
47	22670	22.30	51.30	9.35	4.47	51.16	26.27	2.52	1.17	3.62	1.25	1.95
48	22671	22.80	51.50	9.40	4.08	50.27	26.77	3.17	1.80	3.29	1.10	1.88
49	22672	23.10	50.80	9.59	4.21	50.27	26.95	2.90	1.36	3.34	1.23	1.87
50	22673	23.10	50.70	10.17	4.21	49.64	27.82	2.21	1.10	3.26	1.34	1.79

Breeder No	Lab No	Protein	Oil	Palmitic 16:0	Stearic 18:0	Oleic (O) 18:1	Linoleic(L) 18:2	Arachidic 20:0	Eicosenoic 20:1	Behenic 22:0	Lignoceric 24:0	O/L Ratio
						(%)						
51	22674	23.00	50.20	9.91	3.93	50.16	28.00	2.23	1.22	3.04	1.29	1.80
52	22675	23.20	52.30	9.85	4.42	49.47	27.31	2.47	1.29	3.65	1.19	1.82
53	22676	22.90	53.20	9.47	4.23	50.53	26.72	2.87	1.35	3.42	1.22	1.90
54	22677	22.30	52.80	9.57	4.29	49.60	27.37	3.06	1.68	3.18	1.11	1.82
55	22678	22.80	52.00	9.53	4.01	49.52	27.74	2.93	1.73	3.12	1.25	1.79
Preliminary Confectionery Groundnut Varietal Trial, RP 5,ICRISAT Center, Rainy Season 1988												
1	25765	21.30	49.40	11.68	2.57	43.77	33.69	1.57	1.19	2.72	1.81	1.30
2	25766	18.70	51.30	10.87	4.10	43.44	33.21	1.99	0.90	3.28	1.64	1.31
3	25767	22.00	48.10	10.57	3.01	47.87	28.94	1.64	1.27	3.60	2.14	1.66
4	25768	22.30	49.80	10.65	3.61	49.37	27.37	1.77	1.11	3.38	1.81	1.81
5	25769	21.00	51.00	10.81	2.89	44.93	32.12	1.69	1.17	3.49	2.04	1.40
6	25770	21.00	51.10	11.18	3.55	43.77	32.51	1.86	1.04	3.53	1.77	1.35
7	25771	18.60	54.60	10.35	3.83	49.55	27.63	1.89	1.04	3.41	1.57	1.82
8	25772	19.00	55.00	11.26	3.38	47.12	29.69	1.70	1.10	3.31	1.69	1.59
9	25773	19.50	50.00	11.55	3.09	43.20	32.80	1.75	1.16	3.60	2.01	1.32
10	25774	19.20	49.90	11.22	3.02	42.37	34.42	1.68	1.15	3.44	1.94	1.23
11	25775	19.00	51.20	9.90	4.38	50.88	25.96	2.09	0.93	3.64	1.56	1.96
12	25776	20.70	50.00	10.58	3.66	48.24	28.47	1.95	1.03	3.80	1.63	1.70
13	25777	21.80	50.30	10.77	3.34	46.55	30.30	1.78	1.16	3.64	1.74	1.54
14	25778	18.60	51.00	10.34	3.90	49.38	27.23	2.04	1.02	3.87	1.54	1.82
15	25779	19.70	49.50	10.00	4.23	50.35	26.29	2.16	1.00	3.82	1.57	1.92
16	25780	20.20	47.30	10.79	3.15	47.10	29.21	1.77	1.26	3.72	2.24	1.62
17	25781	20.60	49.80	10.43	3.59	48.35	28.68	1.92	1.15	3.53	1.64	1.69

Breeder No	Lab No	Protein	Oil	Palmitic 16:0	Stearic 18:0	Oleic (O) 18:1	Linoleic(L) 18:2	Arachidic 20:0	Eicosenoic 20:1	Behenic 22:0	Lignoceric 24:0	D/L Ratio
						(%)						
18	25782	21.00	47.80	10.62	3.43	46.27	29.95	1.95	1.25	3.60	2.05	1.55
19	25783	22.80	47.80	10.73	3.68	49.81	26.58	1.95	1.11	3.61	1.76	1.88
20	25784	20.10	52.20	10.38	4.11	46.44	30.07	2.11	0.97	3.54	1.73	1.55
21	25785	18.80	49.50	10.92	3.69	43.37	33.21	1.88	1.01	3.41	1.83	1.31
22	25786	20.60	51.40	10.20	4.07	49.40	26.71	2.09	1.07	4.06	1.76	1.85
23	25787	19.70	50.50	10.53	3.10	46.46	31.11	1.74	1.20	3.46	1.82	1.50
24	25788	19.70	50.30	10.14	4.29	49.57	27.50	2.03	1.02	3.60	1.60	1.81
25	25789	21.10	51.10	11.03	3.49	45.46	30.87	1.86	1.12	3.55	1.69	1.48
26	25790	21.00	46.70	10.10	3.35	48.40	28.82	1.89	1.21	3.74	1.85	1.68
27	25791	19.80	52.10	10.11	4.40	50.01	26.45	2.13	0.98	3.76	1.56	1.89
28	25792	20.50	51.40	10.33	3.84	49.21	27.64	2.00	1.06	3.92	1.62	1.78
29	25793	21.10	50.80	9.98	4.00	51.09	26.67	1.96	0.98	3.08	1.56	1.92
30	25794	22.70	49.50	12.53	3.34	42.11	33.12	1.94	1.08	3.37	1.71	1.28
31	25795	19.20	51.60	10.65	3.70	48.87	28.34	1.81	1.02	3.11	1.73	1.73
32	25796	19.40	50.10	10.13	4.11	49.16	26.89	2.13	1.09	4.17	1.67	1.83
33	25797	20.10	49.00	12.56	3.39	41.61	32.83	2.00	1.16	3.73	1.86	1.27
34	25798	19.00	51.00	10.22	3.64	49.92	26.74	1.99	1.16	3.93	1.71	1.87
35	25799	20.90	48.00	10.28	3.79	49.44	27.08	2.02	1.14	4.07	1.70	1.83
36	25800	18.90	49.50	9.83	4.27	50.45	26.48	2.12	1.00	3.83	1.56	1.91
37	25801	21.20	48.00	12.56	3.22	41.02	33.50	1.92	1.19	3.64	2.11	1.23
38	25802	20.90	51.20	10.56	3.18	49.78	27.85	1.76	1.19	3.35	1.65	1.79
39	25803	17.70	50.70	11.61	4.07	44.74	30.96	2.07	0.94	3.58	1.45	1.45
40	25804	21.00	50.90	10.43	3.76	48.58	27.52	2.06	1.12	4.03	1.83	1.77
41	25805	21.20	51.70	10.45	3.53	49.11	27.94	1.89	1.06	3.79	1.72	1.76

Breeder No	Lab No	Protein	Oil	Palmitic 16:0	Stearic 18:0	Oleic (O) 18:1	Linoleic(L) 18:2	Arachidic 20:0	Eicosenoic 20:1	Behenic 22:0	Lignoceric 24:0	O/L Ratio
						(%)						
42	25806	21.30	50.30	11.25	3.21	44.54	32.03	1.71	1.23	3.39	1.90	1.39
43	25807	21.20	52.20	10.70	3.27	49.15	28.48	1.75	1.12	3.14	1.71	1.73
44	25808	20.60	49.30	10.67	3.85	49.67	27.62	1.83	1.04	2.91	1.63	1.80
45	25809	21.20	49.40	10.63	3.36	49.17	28.45	1.75	1.06	3.13	1.71	1.73
46	25810	21.00	51.10	10.36	3.19	48.52	28.93	1.78	1.23	3.25	1.91	1.68
47	25811	20.60	37.40	9.90	4.17	49.78	26.78	2.14	1.02	3.92	1.63	1.86
48	25812	19.80	51.70	10.12	4.09	50.27	26.21	2.13	1.03	3.90	1.60	1.92
49	25813	20.10	52.60	10.00	4.23	50.14	26.39	2.12	1.02	3.89	1.61	1.90
50	25814	21.00	49.40	10.70	3.46	48.44	28.31	1.90	1.10	3.52	1.81	1.71
51	25815	21.70	49.80	10.38	3.51	50.46	27.14	1.82	1.09	3.25	1.65	1.86
52	25816	19.40	51.10	9.88	4.00	50.35	26.26	2.10	1.06	4.04	1.67	1.92
53	25817	18.80	53.30	9.67	4.25	51.00	25.92	2.14	0.98	3.80	1.62	1.97
54	25818	18.20	54.60	9.88	4.03	51.00	26.38	2.05	0.97	3.46	1.64	1.93
55	25819	20.10	51.00	10.25	3.87	49.67	26.52	2.08	1.10	4.11	1.76	1.87
56	25820	20.10	49.30	11.25	2.84	43.93	32.78	1.68	1.22	3.55	1.98	1.34
57	25821	21.60	49.30	11.37	2.73	48.08	30.00	1.54	1.10	2.65	1.76	1.60
58	25822	22.10	47.60	10.39	3.69	46.63	29.70	1.97	1.21	3.53	2.08	1.57
59	25823	22.50	50.20	10.46	3.45	48.31	29.21	1.89	1.11	3.36	1.64	1.65
60	25824	21.70	48.80	12.73	2.24	38.49	37.63	1.42	1.36	2.96	2.21	1.02
61	25825	22.20	49.70	11.02	3.69	42.93	33.85	1.89	1.00	3.31	1.78	1.27
62	25826	20.60	47.10	11.09	2.88	52.06	26.17	1.41	1.24	2.78	1.71	1.99
63	25827	19.70	46.80	11.22	3.26	51.47	26.29	1.47	1.14	2.75	1.68	1.96
64	25828	20.70	48.10	12.73	2.56	37.98	37.69	1.47	1.38	3.35	2.13	1.01

Breeder No	Lab No	Protein	Oil	Palmitic 16:0	Stearic 18:0	Oleic (O) 18:1	Linoleic(L) 18:2	Arachidic 20:0	Eicosenoic 20:1	Behenic 22:0	Lignoceric 24:0	O/L Ratio
						(%)						
Preliminary Confectionery Groundnut Varietal Trial-1, BIL-5, ICRISAT Center, Rainy Season 1988												
1	25829	19.80	48.80	12.80	2.78	43.19	32.99	1.50	1.16	2.84	1.98	1.31
2	25830	17.40	51.00	11.89	4.55	43.91	31.44	1.96	0.91	3.12	1.55	1.40
3	25831	19.40	44.40	11.09	3.70	48.28	27.38	1.84	1.19	3.93	2.04	1.76
4	25832	21.70	47.20	11.17	4.04	47.99	27.58	1.84	1.14	3.51	1.97	1.74
5	25833	20.70	49.70	11.99	4.03	40.61	34.28	1.94	1.06	3.49	1.90	1.19
6	25834	18.70	51.40	11.58	3.75	44.47	31.03	1.86	1.15	3.60	1.87	1.43
7	25835	19.80	48.40	10.47	4.78	49.50	26.38	2.08	0.97	3.58	1.61	1.88
8	25836	17.50	53.10	11.11	3.99	47.43	28.51	1.96	1.09	3.60	1.63	1.66
9	25837	18.40	49.70	12.04	3.76	41.61	33.69	1.81	1.05	3.45	1.84	1.24
10	25838	19.20	52.40	11.65	4.16	43.77	31.74	1.95	1.01	3.35	1.69	1.38
11	25839	21.00	50.50	10.23	4.78	49.71	26.11	2.10	0.93	3.82	1.65	1.90
12	25840	20.50	50.60	10.58	4.76	48.03	27.40	2.05	1.00	3.69	1.72	1.75
13	25841	19.40	51.50	11.38	3.75	46.00	29.99	1.79	1.11	3.52	1.75	1.53
14	25842	18.50	49.60	10.61	4.91	49.00	26.70	2.11	0.93	3.52	1.51	1.84
15	25843	20.10	49.90	10.27	4.96	49.54	26.32	2.09	0.99	3.68	1.62	1.88
16	25844	19.90	47.70	10.46	5.34	47.44	26.41	2.42	1.02	4.10	2.10	1.80
17	25845	18.60	48.50	10.96	4.09	48.19	27.83	1.97	1.06	3.47	1.76	1.73
18	25846	20.40	48.80	10.94	4.11	46.67	29.65	1.97	1.00	3.18	1.82	1.57
19	25847	21.20	49.50	10.83	4.25	51.57	25.48	1.87	0.94	3.11	1.55	2.02
20	25848	20.50	48.40	10.33	4.30	50.21	25.71	2.03	1.04	3.88	1.70	1.96
21	25849	18.50	48.70	11.48	4.20	44.51	31.40	1.92	1.02	3.27	1.73	1.42
22	25850	17.50	51.10	11.70	4.00	45.57	30.38	1.84	0.99	3.27	1.56	1.50
23	25851	18.00	48.90	11.01	3.63	49.91	27.20	1.78	1.10	3.19	1.44	1.84

Breeder No	Lab No	Protein	Oil	Palmitic 16:0	Stearic 18:0	Oleic (O) 18:1	Linoleic(L) 18:2 (%)	Arachidic 20:0	Eicosenoic 20:1	Behenic 22:0	Lignoceric 24:0	O/L Ratio
24	25852	20.70	49.40	11.22	4.46	45.03	30.64	1.99	0.93	3.56	1.68	1.47
25	25853	18.30	51.00	11.55	3.67	45.80	30.85	1.83	1.06	3.37	1.54	1.51
26	25854	20.50	51.30	10.64	4.15	50.02	27.23	1.89	0.94	2.90	1.48	1.84
27	25855	19.50	48.60	10.74	4.87	49.06	26.30	2.10	1.00	3.57	1.72	1.87
28	25856	19.70	49.20	10.36	4.84	49.19	26.38	2.20	0.97	3.91	1.65	1.87
29	25857	20.40	48.20	10.82	4.57	49.53	26.83	1.96	0.93	3.33	1.56	1.85
30	25858	19.60	48.50	12.75	3.76	41.88	33.62	1.97	0.89	3.12	1.31	1.25
31	25859	17.00	49.20	11.08	4.47	48.89	27.34	1.91	0.92	3.15	1.62	1.79
32	25860	19.50	49.90	10.31	4.95	49.71	25.78	2.18	0.97	3.87	1.67	1.93
33	25861	20.90	48.80	12.71	4.22	40.41	33.17	2.22	0.94	3.81	1.63	1.22
34	25862	19.60	47.80	10.82	4.30	49.25	26.81	1.95	1.07	3.64	1.64	1.84
35	25863	19.80	50.20	10.82	4.50	49.08	27.04	1.88	0.99	3.42	1.59	1.82
36	25864	19.60	49.00	10.82	4.36	49.41	26.55	1.87	1.02	3.46	1.69	1.86
37	25865	20.30	45.30	12.63	3.84	40.30	33.32	2.12	1.02	4.04	1.93	1.21
38	25866	20.90	48.50	10.95	3.61	48.80	28.75	1.79	1.03	3.03	1.44	1.70
39	25867	18.80	49.00	12.42	4.00	41.77	33.29	1.95	0.95	3.48	1.77	1.25
40	25868	22.40	50.60	10.01	4.39	51.95	25.29	1.99	0.92	3.46	1.53	2.05
41	25869	20.30	51.50	9.93	4.60	51.74	25.32	2.06	0.91	3.56	1.57	2.04
42	25870	18.40	49.20	11.72	3.31	43.04	33.00	1.78	1.18	3.68	1.72	1.30
43	25871	17.60	50.10	11.27	3.70	49.28	27.82	1.69	1.03	2.98	1.59	1.77
44	25872	19.00	48.00	10.85	4.09	50.00	27.12	1.89	0.98	3.15	1.53	1.84
45	25873	18.90	51.20	11.06	4.08	50.01	27.05	1.79	0.97	3.14	1.57	1.85
46	25874	17.90	49.40	11.33	4.24	47.78	28.29	1.89	1.00	3.18	1.65	1.69
47	25875	19.10	38.70	10.27	4.69	50.21	26.15	2.06	0.96	3.69	1.63	1.92

Breeder No	Lab No	Protein	Oil	Palmitic 16:0	Stearic 18:0	Oleic (O) 18:1	Linoleic(L) 18:2	Arachidic 20:0	Eicosenoic 20:1	Behenic 22:0	Lignoceric 24:0	O/L Ratio
						(%)						
48	25876	19.90	53.20	10.64	4.67	49.44	26.03	2.07	1.01	3.83	1.64	1.90
49	25877	19.80	48.80	10.27	4.97	49.51	25.83	2.19	0.99	3.92	1.69	1.92
50	25878	20.80	48.40	11.15	3.99	48.32	28.12	1.88	0.97	3.40	1.60	1.72
51	25879	19.50	48.40	11.30	4.11	49.10	27.71	1.85	0.95	3.08	1.57	1.77
52	25880	19.40	50.80	10.36	4.92	49.58	26.30	2.08	1.00	3.63	1.65	1.89
53	25881	18.90	50.20	10.46	5.41	49.29	25.87	2.18	0.89	3.74	1.58	1.91
54	25882	19.90	48.40	10.70	4.79	48.39	27.03	2.12	0.95	3.89	1.67	1.79
55	25883	20.40	51.20	10.44	4.75	50.70	25.45	2.04	0.89	3.31	1.53	2.00
56	25884	18.40	50.00	11.88	3.30	42.42	33.56	1.67	1.12	3.45	1.78	1.27
57	25885	20.10	49.90	11.65	3.24	48.41	29.20	1.60	0.96	2.58	1.57	1.66
58	25886	19.50	48.60	11.75	3.41	46.93	29.70	1.73	1.00	2.96	1.86	1.58
59	25887	18.70	51.50	10.76	4.23	48.64	28.36	1.93	0.97	3.26	1.55	1.72
60	25888	22.00	44.50	13.41	2.03	37.08	38.21	1.37	1.42	3.43	2.19	0.97
61	25889	19.40	48.00	11.60	3.80	42.98	33.39	1.92	1.12	3.73	1.89	1.27
62	25890	18.60	51.60	11.20	2.78	49.59	28.75	1.45	1.17	2.47	1.75	1.73
63	25891	19.20	50.80	10.84	3.23	50.81	27.51	1.51	1.18	2.81	1.63	1.85
64	25892	17.80	46.50	13.22	2.00	36.80	38.75	1.41	1.51	3.76	1.99	0.95
Preliminery Confectionery Groundnut Varietal Trial 2, RP 5, ICRISAT Center, Rainy Season 1988												
1	25893	20.60	50.60	10.74	2.49	49.25	29.81	1.46	1.28	2.52	1.63	1.66
2	25894	19.90	50.00	11.20	2.28	47.80	30.44	1.36	1.30	2.79	1.95	1.57
3	25895	20.80	49.40	10.19	2.78	46.86	31.22	1.61	1.37	2.98	1.93	1.50
4	25896	20.00	53.60	10.86	2.72	46.82	31.40	1.57	1.21	2.91	1.83	1.50
5	25897	20.70	52.60	10.75	2.52	48.97	29.27	1.58	1.33	3.01	1.84	1.67

Breeder No	Lab No	Protein	Oil	Palmitic 16:0	Stearic 18:0	Oleic (O) 18:1	Linoleic(L) 18:2	Arachidic 20:0	Eicosenoic 20:1	Behenic 22:0	Lignoceric 24:0	O/L Ratio
						(%)						
6	25898	21.60	51.30	10.52	3.26	48.16	30.22	1.73	0.98	2.70	1.53	1.59
7	25899	20.20	51.70	10.28	3.38	49.96	28.52	1.79	1.09	2.97	1.47	1.75
8	25900	19.70	52.40	10.49	3.05	48.15	30.52	1.63	1.17	2.64	1.65	1.58
9	25901	20.00	51.30	8.64	3.49	60.67	19.60	1.77	1.14	2.75	1.29	3.08
10	25902	20.40	52.70	10.21	2.80	50.49	27.66	1.62	1.24	3.16	1.76	1.83
11	25903	21.70	51.40	10.86	2.49	44.60	32.98	1.54	1.31	3.06	2.05	1.35
12	25904	19.90	51.70	10.76	2.58	48.17	29.98	1.55	1.28	3.05	1.73	1.61
13	25905	20.50	51.30	10.57	2.71	50.17	28.40	1.59	1.28	2.98	1.68	1.77
14	25906	18.20	51.60	11.03	2.59	51.39	27.70	1.42	1.18	2.47	1.43	1.86
15	25907	19.90	51.40	10.45	2.54	52.23	26.95	1.48	1.36	2.51	1.63	1.94
16	25908	22.00	52.50	10.62	2.85	49.01	29.18	1.60	1.26	2.81	1.70	1.68
17	25909	19.50	52.10	10.66	2.41	48.85	30.05	1.45	1.38	2.78	1.75	1.63
18	25910	20.80	52.10	10.39	2.36	50.48	28.98	1.38	1.26	2.60	1.71	1.74
19	25911	21.50	53.00	11.07	2.37	46.17	31.71	1.48	1.37	2.98	2.00	1.46
20	25912	20.20	49.10	10.79	2.92	47.30	30.68	1.69	1.25	3.03	1.71	1.54
21	25913	20.70	51.90	11.11	2.61	44.08	33.74	1.59	1.31	3.04	1.84	1.31
22	25914	23.40	50.20	10.22	2.69	47.10	31.35	1.61	1.29	2.89	1.93	1.50
23	25915	19.30	51.80	8.76	3.49	59.71	20.69	1.76	1.07	2.76	1.27	2.89
24	25916	18.40	50.90	10.38	2.45	50.91	28.25	1.44	1.35	2.69	1.72	1.80
25	25917	20.70	39.70	10.87	2.77	47.05	30.66	1.62	1.27	3.00	1.88	1.54
26	25918	23.30	46.70	10.68	2.86	47.62	29.81	1.68	1.25	3.15	2.03	1.60
27	25919	21.00	48.30	10.39	2.60	52.23	26.93	1.39	1.28	2.79	1.73	1.94
28	25920	20.30	49.90	10.25	2.49	51.57	27.03	1.45	1.41	2.99	1.85	1.91
29	25921	21.50	49.30	10.10	2.39	51.68	27.37	1.41	1.43	3.03	1.79	1.89

Breeder No	Lab No	Protein	Oil	Palmitic 16:0	Stearic 18:0	Oleic (O) 18:1	Linoleic(L) 18:2	Arachidic 20:0	Eicosenoic 20:1	Behenic 22:0	Lignoceric 24:0	O/L Ratio
						(%)						
30	25922	20.60	51.70	12.57	2.33	38.21	37.68	1.47	1.39	3.16	2.14	1.02
Preliminary Confectionery Groundnut Varietal Trial-2, BIL 5, ICRISAT Center, Rainy Season 1988												
1	25923	18.10	45.90	12.08	2.51	46.09	31.12	1.43	1.42	3.01	1.53	1.49
2	25924	19.10	47.30	11.99	2.59	46.61	30.41	1.40	1.39	3.05	1.90	1.54
3	25925	17.20	45.90	11.61	2.50	44.16	32.70	1.47	1.43	3.44	1.90	1.35
4	25926	16.40	44.50	11.66	3.81	43.64	31.92	1.92	1.12	3.60	1.78	1.37
5	25927	18.00	52.70	12.25	3.09	44.19	32.26	1.67	1.21	3.01	1.67	1.37
6	25928	19.80	44.50	12.40	2.56	44.41	32.13	1.52	1.35	3.36	1.63	1.39
7	25929	20.20	50.00	10.44	3.21	49.47	28.94	1.79	1.15	3.07	1.53	1.71
8	25930	17.80	48.70	11.48	2.86	45.44	31.98	1.57	1.19	3.10	1.73	1.42
9	25931	17.40	44.40	11.43	2.85	45.34	31.89	1.61	1.27	3.08	1.71	1.43
10	25932	17.50	49.60	11.99	3.04	46.03	30.58	1.60	1.22	3.03	1.52	1.51
11	25933	18.10	46.40	12.04	2.59	43.30	32.90	1.46	1.29	3.50	1.95	1.32
12	25934	18.40	46.90	12.34	2.83	45.00	31.26	1.52	1.28	3.16	1.68	1.44
13	25935	17.30	50.70	11.81	2.72	47.93	29.75	1.36	1.12	2.78	1.66	1.62
14	25936	16.20	47.40	12.16	3.04	47.63	29.31	1.51	1.19	2.84	1.52	1.63
15	25937	20.20	44.40	14.35	2.86	40.47	33.39	1.55	1.21	3.56	1.68	1.22
16	25938	20.20	43.80	12.30	2.79	45.53	38.52	1.42	1.28	3.28	1.82	1.19
17	25939	17.10	51.50	11.71	2.93	46.74	30.72	1.42	1.14	2.61	1.80	1.53
18	25940	16.70	52.20	11.30	2.82	48.50	29.10	1.45	1.31	2.76	1.80	1.67
19	25941	16.40	50.20	11.84	2.63	46.36	30.44	1.44	1.33	3.05	1.96	1.53
20	25942	16.60	47.50	12.15	3.34	43.19	32.35	1.70	1.20	3.22	1.88	1.34
21	25943	17.70	46.70	11.89	3.04	43.25	32.52	1.68	1.33	3.53	1.82	1.33

Breeder No	Lab No	Protein	Oil	Palmitic 16:0	Stearic 18:0	Oleic (O) 18:1	Linoleic(L) 18:2	Arachidic 20:0	Eicosenoic 20:1	Behenic 22:0	Lignoceric 24:0	O/L Ratio
						(%)						
22	25944	19.20	50.30	11.46	2.85	45.27	31.75	1.45	1.20	3.10	1.88	1.43
23	25945	16.90	46.00	10.43	3.28	53.42	24.38	1.67	1.18	3.47	1.34	2.20
24	25946	17.10	49.80	11.76	2.82	48.11	29.54	1.38	1.17	2.63	1.65	1.63
25	25947	18.50	43.40	12.21	2.58	43.70	32.18	1.46	1.34	3.64	1.88	1.36
26	25948	17.90	50.10	11.78	3.17	46.75	30.28	1.51	1.02	2.64	1.59	1.55
27	25949	18.90	40.50	11.67	2.58	47.92	28.63	1.32	1.35	3.30	1.71	1.68
28	25950	21.00	49.30	10.50	2.43	49.62	29.01	1.31	1.28	2.75	1.78	1.71
29	25951	18.30	50.70	11.24	3.00	49.14	28.68	1.37	1.10	2.64	1.64	1.72
30	25952	18.20	44.90	11.12	1.90	36.41	38.48	1.25	1.56	3.79	2.02	0.95
Quality Studies Trial, RP 3, ICRISAT Center, Rainy Season 1988												
1-1	25953	18.00	51.20	12.00	5.90	40.03	32.98	2.41	0.73	3.86	1.24	1.22
1-2	25954	16.40	51.90	11.65	6.61	40.87	31.91	2.64	0.68	3.94	1.30	1.28
1-3	25955	15.90	50.30	11.40	6.78	40.27	32.13	2.74	0.70	3.99	1.19	1.26
2-1	25956	21.20	51.80	12.25	2.94	43.83	33.07	1.51	1.14	3.20	1.78	1.31
2-2	25957	20.70	52.50	12.29	2.93	43.70	32.56	1.49	1.17	3.22	1.77	1.35
2-3	25958	18.90	51.40	12.43	3.05	43.85	32.26	1.50	1.13	3.07	1.69	1.36
3-1	25959	20.80	48.50	10.96	3.86	49.13	28.05	1.65	1.05	3.07	1.52	1.76
3-2	25960	21.90	47.90	10.64	3.62	51.34	26.37	1.61	1.14	3.05	1.41	1.95
3-3	25961	20.20	50.20	10.43	3.76	52.57	25.74	1.62	1.04	2.75	1.28	2.05
4-1	25962	22.00	47.10	12.36	3.60	38.03	36.91	1.77	1.00	3.84	1.58	1.03
4-2	25963	20.00	44.60	12.66	4.00	36.77	37.19	1.93	0.98	4.09	1.58	0.99
4-3	25964	18.00	48.10	12.50	4.69	37.56	36.12	2.05	0.89	3.92	1.58	1.04
5-1	25965	20.50	51.40	12.00	3.35	39.08	37.14	1.73	1.05	3.38	1.65	1.06

Breeder No	Lab No	Protein	Oil	Palmitic 16:0	Stearic 18:0	Oleic (O) 18:1	Linoleic(L) 18:2	Arachidic 20:0	Eicosenoic 20:1	Behenic 22:0	Lignoceric 24:0	O/L Ratio
						(%)						
5-2	25966	19.40	53.30	11.81	3.31	39.30	37.37	1.70	1.06	3.27	1.55	1.06
5-3	25967	18.50	51.70	11.94	3.57	39.27	36.90	1.79	1.01	3.34	1.50	1.07
6-1	25968	19.40	53.50	11.47	3.74	39.86	36.60	1.86	0.97	3.24	1.55	1.09
6-2	25969	18.50	51.20	11.60	3.71	38.97	37.04	1.89	1.02	3.49	1.63	1.06
6-3	25970	17.90	50.60	11.97	3.46	39.01	36.77	1.80	1.06	3.52	1.66	1.06
7-1	25971	17.60	53.60	11.11	4.19	40.21	36.26	1.98	0.93	3.45	1.43	1.11
7-2	25972	17.10	53.30	11.22	4.46	40.27	35.55	2.06	0.90	3.61	1.48	1.14
7-3	25973	18.70	50.40	11.21	4.49	39.73	35.91	2.10	0.93	3.74	1.47	1.11
8-1	25974	19.50	53.60	11.20	3.74	39.78	36.74	1.86	1.09	3.36	1.50	1.09
8-2	25975	17.10	54.90	11.19	4.36	39.30	36.77	2.00	0.99	3.35	1.59	1.07
8-3	25976	16.80	52.90	10.94	4.78	39.81	36.35	2.03	0.88	3.29	1.42	1.10
9-1	25977	20.10	51.60	10.18	2.94	52.46	26.61	1.52	1.25	2.58	1.43	1.98
9-2	25978	19.30	53.40	10.47	2.90	52.64	26.57	1.44	1.10	2.44	1.43	1.99
9-3	25979	19.40	51.20	10.11	3.07	53.48	25.91	1.53	1.19	2.44	1.40	2.07
10-1	25980	23.10	47.20	10.33	2.83	49.90	28.05	1.62	1.28	3.22	1.81	1.78
10-2	25981	20.40	54.10	9.92	2.90	54.08	25.38	1.50	1.08	2.67	1.54	2.13
10-3	25982	19.30	54.80	10.12	3.15	52.82	26.29	1.58	1.00	2.55	1.45	2.01
11-1	25983	17.60	52.40	11.67	2.66	43.84	33.40	1.44	1.32	3.01	1.58	1.32
11-2	25984	18.80	51.80	11.18	2.86	47.95	29.38	1.48	1.36	2.96	1.65	1.64
11-3	25985	19.30	53.90	11.45	2.65	45.46	31.90	1.44	1.37	2.91	1.61	1.43
12-1	25986	21.60	50.10	12.64	3.85	37.66	37.16	1.85	0.98	3.50	1.51	1.02
12-2	25987	24.80	46.40	13.03	3.43	36.86	37.62	1.74	1.05	3.66	1.65	0.98
12-3	25988	22.30	49.30	13.04	3.98	36.69	37.07	1.91	0.99	3.75	1.66	0.99
13-1	25989	19.50	48.90	12.78	2.18	37.48	38.41	1.41	1.50	3.31	1.73	0.98

Breeder No	Lab No	Protein	Oil	Palmitic 16:0	Stearic 18:0	Oleic (O) 18:1	Linoleic(L) 18:2	Arachidic 20:0	Eicosenoic 20:1	Behenic 22:0	Lignoceric 24:0	O/L Ratio
						(%)						
13-2	25990	18.40	48.00	12.73	2.25	37.86	38.10	1.43	1.45	3.32	1.81	1.00
13-3	25991	19.60	48.50	12.83	2.19	37.81	37.83	1.41	1.51	3.39	1.95	1.00
					Quality Studies Trial, Hisar, Rainy Season 1988							
1-1	25992	25.10	49.10	11.88	3.50	40.20	35.29	1.86	1.10	3.50	1.61	1.14
1-2	25993	24.60	49.70	11.87	3.06	39.84	36.33	1.70	1.23	3.37	1.65	1.10
1-3	25994	24.20	50.10	12.00	3.61	39.47	35.96	1.89	1.08	3.57	1.51	1.10
2-1	25995	24.00	50.70	10.97	2.37	37.31	38.22	1.64	1.81	4.07	2.38	0.98
2-2	25996	25.60	49.40	11.22	2.67	36.75	38.57	1.66	1.64	3.92	2.26	0.96
2-3	25997	22.80	52.30	11.22	2.15	36.85	38.56	1.55	1.87	4.10	2.36	0.96
3-1	25998	23.20	57.60	9.08	3.20	54.78	25.03	1.69	1.15	2.85	1.36	2.19
3-2	25999	22.40	54.50	9.36	3.38	53.62	25.65	1.73	1.17	2.84	1.34	2.09
3-3	26000	22.80	54.80	9.31	3.23	53.39	25.78	1.71	1.24	2.90	1.41	2.07
4-1	26001	26.80	47.70	11.74	3.42	37.54	38.22	1.72	1.09	3.44	1.80	0.99
4-2	26002	25.40	46.50	11.60	3.33	36.66	39.34	1.77	1.11	3.44	1.71	0.94
4-3	26003	24.30	49.90	11.54	3.02	37.15	39.33	1.70	1.13	3.47	1.71	0.95
5-1	26004	27.70	47.00	10.95	2.93	36.98	39.11	1.73	1.47	3.50	2.13	0.95
5-2	26005	30.90	46.00	11.15	3.15	38.98	37.56	1.78	1.22	3.22	2.12	1.04
5-3	26006	27.00	46.40	10.87	2.89	38.06	38.58	1.70	1.38	3.43	1.93	0.99
6-1	26007	28.00	47.90	10.72	2.55	36.43	39.94	1.64	1.55	3.76	2.14	0.92
6-2	26008	27.30	48.20	10.85	3.00	38.16	38.52	1.75	1.28	3.39	1.90	0.99
6-3	26009	27.20	48.10	10.97	2.82	35.92	40.04	1.70	1.50	3.67	2.06	0.90
7-1	26010	26.90	49.10	10.47	3.50	41.32	35.61	1.83	1.09	3.22	1.70	1.16
7-2	26011	27.00	49.50	10.63	3.22	39.94	37.58	1.77	1.17	3.26	1.69	1.07

Breeder No	Lab No	Protein	Oil	Palmitic 16:0	Stearic 18:0	Oleic (O) 18:1	Linoleic(L) 18:2	Arachidic 20:0	Eicosenoic 20:1	Behenic 22:0	Lignoceric 24:0	O/L Ratio
						(%)						
7-3	26012	27.40	47.90	10.40	3.42	40.85	36.20	1.85	1.19	3.31	1.74	1.13
8-1	26013	27.50	46.30	10.36	3.58	36.50	39.31	1.90	1.48	3.72	2.01	0.93
8-2	26014	27.80	46.80	10.43	3.66	37.12	38.52	1.98	1.49	3.84	1.94	0.97
8-3	26015	27.90	47.50	10.79	3.41	37.53	37.82	1.90	1.46	4.02	2.06	1.00
9-1	26016	20.20	49.70	10.03	2.60	45.96	32.04	1.53	1.69	3.03	1.84	1.44
9-2	26017	20.20	49.00	9.81	2.51	47.12	31.10	1.50	1.69	3.05	1.87	1.52
9-3	26018	19.30	51.20	10.04	2.58	48.61	29.86	1.49	1.59	2.90	1.67	1.63
10-1	26019	23.10	52.70	9.98	2.50	46.51	31.52	1.51	1.50	3.15	2.02	1.48
10-1	26020	20.40	52.70	9.96	2.57	43.30	34.06	1.65	1.86	3.67	1.98	1.28
10-3	26021	21.10	54.80	9.54	2.81	51.78	27.46	1.64	1.23	3.00	1.66	1.89
11-1	26022	20.80	54.00	11.45	2.33	40.70	37.21	1.39	1.27	2.70	1.86	1.10
11-2	26023	18.90	56.90	10.54	2.80	46.76	31.84	1.52	1.33	2.66	1.56	1.47
11-3	26024	20.10	55.10	10.45	2.67	46.47	31.96	1.51	1.30	2.71	1.60	1.46
12-1	26025	28.30	50.00	12.41	3.21	37.37	38.29	1.68	0.98	3.05	1.68	0.98
12-2	26026	28.00	50.70	11.86	3.17	39.07	37.71	1.65	0.96	2.91	1.54	1.04
12-3	26027	25.40	49.90	12.31	3.14	36.99	38.72	1.76	1.16	3.37	1.66	0.96
13-1	26028	23.10	53.50	11.26	2.36	37.05	39.25	1.50	1.67	3.13	2.27	0.95
13-2	26029	23.50	53.60	11.57	2.53	39.72	36.97	1.52	1.37	2.78	2.10	1.08
13-3	26030	23.60	53.10	11.67	2.22	37.89	38.78	1.45	1.39	2.85	2.16	0.98
Quality Studies Trial, Dharwad, Rainy Season 1988												
1-1	26031	24.20	42.40	12.10	4.96	37.65	34.60	2.19	1.05	4.62	1.74	1.09
1-2	26032	23.50	42.40	12.07	5.10	37.37	34.82	2.26	1.06	4.62	1.68	1.08
1-3	26033	23.80	42.70	12.28	4.23	37.93	35.34	1.99	1.09	4.40	1.73	1.08

Breeder No	Lab No	Protein	Oil	Palmitic 16:0	Stearic 18:0	Oleic (O) 18:1	Linoleic(L) 18:2	Arachidic 20:0	Eicosenoic 20:1	Behenic 22:0	Lignoceric 24:0	O/L Ratio
						(%)						
2-1	26034	24.70	48.30	11.73	2.25	43.53	32.82	1.46	1.47	3.68	2.09	1.33
2-2	26035	25.20	49.60	12.00	2.25	42.47	33.65	1.44	1.45	3.57	2.04	1.27
2-3	26036	26.20	46.00	12.20	2.30	42.09	33.30	1.39	1.46	3.84	2.16	1.27
3-1	26037	25.40	46.20	10.21	2.91	51.37	26.47	1.59	1.29	3.39	1.57	1.94
3-2	26038	26.80	46.60	10.28	2.81	51.11	26.90	1.54	1.29	3.35	1.60	1.90
3-3	26039	25.90	44.90	10.73	2.83	50.11	27.63	1.48	1.21	3.28	1.56	1.82
4-1	26040	25.60	40.40	12.55	2.55	34.76	39.23	1.63	1.34	4.65	2.10	0.89
4-2	26041	26.10	40.40	12.53	2.69	34.89	38.90	1.64	1.35	4.65	2.03	0.90
4-3	26042	25.50	40.00	13.02	2.53	34.17	39.03	1.60	1.32	5.11	2.16	0.88
5-1	26043	27.80	45.50	11.80	2.44	36.33	39.69	1.51	1.38	3.80	1.96	0.92
5-2	26044	25.70	46.80	11.91	2.45	36.31	39.49	1.53	1.40	3.88	1.94	0.92
5-3	26045	25.80	44.30	11.81	2.44	36.50	39.28	1.55	1.39	3.96	1.95	0.93
6-1	26046	28.10	45.10	11.80	2.33	35.74	39.93	1.51	1.42	3.93	2.05	0.90
6-2	26047	26.60	45.30	11.89	2.34	35.67	40.34	1.53	1.43	4.26	1.97	0.89
6-3	26048	27.80	44.10	11.52	2.23	35.84	39.83	1.53	1.47	4.23	2.05	0.90
7-1	26049	28.00	47.20	11.33	2.80	37.29	38.64	1.67	1.24	3.88	1.89	0.97
7-2	26050	27.70	42.50	11.84	2.64	37.00	38.61	1.51	1.26	4.02	1.94	0.96
7-3	26051	26.60	44.80	11.46	2.77	37.78	38.17	1.63	1.27	3.99	1.88	0.99
8-1	26052	26.60	46.20	11.32	2.86	37.16	38.99	1.57	1.28	3.89	1.87	0.96
8-2	26053	26.50	45.10	11.68	2.77	36.51	39.24	1.58	1.39	3.98	2.07	0.93
8-3	26054	27.30	45.00	11.55	2.79	36.79	39.17	1.60	1.35	3.92	2.05	0.94
9-1	26055	20.10	49.50	9.78	2.69	49.43	29.32	1.48	1.56	3.00	1.79	1.69
9-2	26056	19.60	44.30	10.24	2.64	45.21	32.23	1.51	1.72	3.37	1.96	1.41
9-3	26057	20.10	45.00	10.30	2.44	43.04	34.42	1.51	1.91	3.35	2.13	1.25

Breeder No	Lab No	Protein	Oil	Palmitic 16:0	Stearic 18:0	Oleic (O) 18:1	Linoleic(L) 18:2	Arachidic 20:0	Eicosenoic 20:1	Behenic 22:0	Lignoceric 24:0	O/L Ratio
						(%)						
10-1	26058	26.80	43.40	9.86	2.31	52.44	26.34	1.51	1.35	3.33	1.81	1.99
10-2	26059	26.30	47.30	9.83	2.24	52.93	26.38	1.43	1.40	3.10	1.82	2.01
10-3	26060	25.20	46.50	10.09	2.28	50.73	28.03	1.48	1.38	3.18	1.97	1.81
11-1	26061	24.00	45.30	10.73	2.34	47.64	30.55	1.30	1.40	3.17	1.73	1.56
11-2	26062	24.20	44.40	10.84	2.58	47.54	30.31	1.40	1.40	3.10	1.71	1.57
11-3	26063	23.20	43.10	11.12	2.31	46.03	31.70	1.35	1.47	3.21	1.68	1.46
12-1	26064	26.90	42.10	13.07	3.26	35.94	37.55	1.77	1.27	4.35	2.02	0.96
12-2	26065	26.50	41.00	12.96	3.54	35.33	37.90	1.82	1.22	4.23	1.89	0.94
12-3	26066	26.80	40.00	12.70	4.13	35.45	37.69	1.95	1.11	4.05	1.82	0.94
13-1	26067	23.80	40.30	12.60	2.02	36.70	39.31	1.32	1.58	3.58	2.11	0.94
13-2	26068	24.30	40.90	12.35	1.91	36.73	39.00	1.31	1.65	3.73	2.02	0.95
13-3	26069	24.30	40.00	12.29	1.93	36.81	39.18	1.31	1.59	3.59	2.03	0.94
ICRISAT Confectionery Groundnut Varieties, ICRISAT Center, Postrainy Season 1988/89												
88355	26762	24.80	45.40	10.81	2.19	44.71	33.54	1.35	1.46	3.01	1.84	1.33
88356	26763	18.80	49.10	11.03	3.25	41.54	35.73	1.66	1.16	3.43	1.50	1.16
88357	26764	22.00	47.30	10.72	2.76	44.77	32.56	1.50	1.36	3.64	1.89	1.38
88358	26765	21.90	47.80	10.39	2.66	47.74	30.35	1.42	1.47	3.33	1.86	1.57
88359	26766	21.40	49.90	10.11	2.49	45.14	32.56	1.51	1.54	3.82	2.08	1.39
88360	26767	19.70	51.30	10.39	3.49	44.74	32.40	1.82	1.23	3.72	1.58	1.38
88361	26768	20.10	50.90	10.37	3.20	44.52	33.31	1.67	1.28	3.37	1.61	1.34
88362	26769	18.60	54.50	10.54	3.37	47.42	29.96	1.76	1.21	3.66	1.52	1.58
88363	26770	20.20	47.60	10.15	2.68	45.71	32.15	1.55	1.53	3.67	1.86	1.42
88364	26771	20.90	48.10	11.24	2.74	39.54	37.46	1.62	1.39	3.57	1.76	1.06

Breeder No	Lab No	Protein	Oil	Palmitic 16:0	Stearic 18:0	Oleic (O) 18:1	Linoleic(L) 18:2	Arachidic 20:0	Eicosenoic 20:1	Behenic 22:0	Lignoceric 24:0	O/L Ratio
						(%)						
88365	26772	23.30	51.00	9.38	3.93	49.77	27.11	2.06	1.24	4.27	1.63	1.84
88366	26773	23.50	48.10	9.62	3.43	49.01	28.28	1.89	1.34	4.11	1.69	1.73
88367	26774	23.20	49.90	9.95	2.91	47.38	30.34	1.70	1.33	4.15	1.68	1.56
88368	26775	22.30	50.20	10.14	3.58	48.08	28.41	1.82	1.18	4.18	1.41	1.69
88369	26776	23.30	48.80	9.54	3.94	48.79	27.90	2.06	1.27	4.26	1.68	1.75
88370	26777	22.70	47.10	10.51	2.68	44.61	32.45	1.63	1.55	3.89	2.02	1.37
88371	26778	21.90	50.50	9.59	3.13	49.44	28.88	1.72	1.32	3.72	1.64	1.71
88372	26779	23.90	45.70	10.26	3.23	45.99	31.19	1.77	1.31	3.73	1.89	1.47
88373	26780	21.20	48.00	10.19	3.76	50.49	27.51	1.88	1.04	3.28	1.40	1.84
88374	26781	24.00	47.20	9.82	3.87	45.04	31.49	1.99	1.26	4.16	1.81	1.43
88375	26782	23.00	47.60	9.83	3.73	45.65	31.94	1.84	1.24	3.51	1.68	1.43
88376	26783	21.00	48.30	10.08	3.41	48.06	29.50	1.82	1.29	3.75	1.60	1.63
88377	26784	24.10	46.80	9.78	2.89	48.07	30.09	1.66	1.50	3.60	1.78	1.60
88378	26785	24.30	48.60	9.80	3.61	48.71	28.58	1.94	1.28	3.97	1.62	1.70
88379	26786	19.80	49.80	10.45	3.03	46.60	31.10	1.68	1.30	3.65	1.70	1.50
88380	26787	23.10	47.50	9.57	2.71	48.26	30.07	1.62	1.44	3.90	1.87	1.60
88381	26788	21.30	48.60	9.72	4.04	49.53	27.55	2.07	1.16	3.91	1.56	1.80
88382	26789	24.30	50.40	9.71	3.73	49.20	28.02	1.87	1.23	4.07	1.66	1.76
88383	26790	23.40	47.20	10.14	3.53	48.26	28.92	1.83	1.28	3.76	1.63	1.67
88384	26791	26.50	47.30	11.63	3.32	41.54	34.89	1.85	1.16	3.03	1.76	1.19
88385	26792	21.30	48.80	10.02	3.36	48.75	29.08	1.73	1.26	3.51	1.62	1.68
88386	26793	21.00	51.30	9.92	3.91	48.25	28.63	2.00	1.16	4.15	1.55	1.69
88387	26794	24.50	46.90	11.78	3.33	42.42	34.23	1.80	1.07	3.08	1.70	1.24
88388	26795	23.10	47.60	9.89	3.52	48.25	28.72	1.94	1.35	4.22	1.63	1.68

Breeder No	Lab No	Protein	Oil	Palmitic 16:0	Stearic 18:0	Oleic (O) 18:1	Linoleic(L) 18:2	Arachidic 20:0	Eicosenoic 20:1	Behenic 22:0	Lignoceric 24:0	O/L Ratio
						(%)						
88389	26796	21.90	48.40	9.80	4.07	48.30	28.64	2.02	1.12	3.90	1.51	1.69
88390	26797	23.70	50.40	9.56	3.57	49.94	27.31	1.97	1.30	4.24	1.64	1.83
88391	26798	24.00	45.50	12.21	3.37	40.88	35.01	1.81	1.10	3.08	1.78	1.17
88392	26799	24.40	45.80	9.85	3.19	48.77	29.61	1.66	1.30	3.42	1.71	1.65
88393	26800	21.40	49.40	10.64	4.29	46.16	30.80	1.97	1.00	3.35	1.39	1.50
88394	26801	23.30	48.40	9.74	3.40	49.76	28.21	1.78	1.21	3.84	1.60	1.76
88395	26802	24.20	46.20	9.89	3.48	48.30	29.05	1.84	1.34	4.00	1.61	1.66
88396	26803	21.80	50.30	10.77	3.55	42.91	33.91	1.85	1.17	3.61	1.69	1.27
88397	26804	25.40	45.20	10.06	2.69	48.61	29.78	1.58	1.37	3.62	1.75	1.63
88398	26805	24.80	48.20	10.20	3.22	47.10	30.82	1.75	1.25	3.21	1.64	1.53
88399	26806	24.70	47.70	9.87	3.42	49.61	28.17	1.77	1.21	3.59	1.62	1.76
88340	26807	25.30	47.80	9.96	3.59	48.44	28.78	1.90	1.24	4.00	1.63	1.68
88401	26808	21.70	49.20	9.37	3.73	48.73	27.34	1.82	1.18	5.55	1.59	1.78
88402	26809	22.10	50.00	9.88	3.54	48.47	28.82	1.79	1.24	3.92	1.57	1.68
88403	26810	23.30	48.50	9.31	4.68	49.89	26.66	2.14	1.14	4.15	1.44	1.87
88404	26811	22.00	47.40	10.33	3.43	47.87	30.06	1.75	1.07	3.35	1.45	1.59
88405	26812	22.20	47.30	10.13	2.73	46.71	30.72	1.60	1.47	3.87	1.86	1.52
88406	26813	20.60	53.00	9.68	4.26	48.31	28.17	2.13	1.13	4.15	1.47	1.71
88407	26814	21.30	48.60	9.76	4.02	50.13	27.66	1.98	1.06	3.58	1.34	1.81
88408	26815	18.90	48.90	9.79	4.05	49.05	27.57	2.08	1.13	4.13	1.45	1.78
88409	26816	22.10	48.20	10.83	3.09	43.22	33.93	1.67	1.31	3.76	1.68	1.27
88410	26817	19.90	49.60	10.26	3.57	45.65	30.94	1.92	1.29	3.97	1.61	1.48
88411	26818	22.70	47.20	10.63	2.77	48.02	30.88	1.54	1.09	2.81	1.51	1.56
88412	26819	21.00	49.70	10.37	3.03	45.42	32.77	1.66	1.23	3.10	1.68	1.39

Breeder No	Lab No	Protein	Oil	Palmitic 16:0	Stearic 18:0	Oleic (O) 18:1	Linoleic(L) 18:2	Arachidic 20:0	Eicosenoic 20:1	Behenic 22:0	Lignoceric 24:0	O/L Ratio
						(%)						
88413	26820	22.40	47.40	11.54	2.17	38.84	38.32	1.38	1.58	2.99	2.06	1.01
88414	26821	31.10	46.20	10.02	3.29	48.15	29.84	1.70	1.24	3.49	1.51	1.61
88415	26822	23.10	48.20	10.76	3.81	37.51	38.64	2.00	1.22	3.52	1.71	0.97
88564	26823	20.70	49.60	11.47	2.27	37.67	39.72	1.37	1.49	3.11	1.81	0.95
CHANDRA	26824	21.80	48.40	9.27	3.25	53.72	25.69	1.67	1.23	2.97	1.44	2.09
87123	26825	18.80	50.80	9.60	2.82	47.53	31.55	1.55	1.38	2.81	1.78	1.51
88416	26826	23.40	48.70	10.13	2.87	45.36	33.37	1.59	1.27	2.74	1.78	1.36
88417	26827	19.00	50.00	9.21	2.42	45.76	33.05	1.46	1.65	3.05	2.17	1.38
88418	26828	26.30	48.00	10.68	2.44	46.93	32.24	1.30	1.36	2.50	1.55	1.46
88421	26829	23.60	47.30	9.70	2.77	47.57	31.67	1.42	1.34	2.65	1.60	1.50
88423	26830	24.20	50.00	11.09	2.57	38.63	39.08	1.46	1.53	2.88	1.75	0.99
88424	26831	20.60	50.30	10.16	2.91	48.17	29.63	1.61	1.43	3.72	1.74	1.63
88426	26832	25.30	48.30	9.89	2.76	44.95	33.24	1.61	1.44	3.16	2.01	1.35
88429	26833	20.90	47.90	9.99	2.71	51.19	28.54	1.39	1.32	2.55	1.56	1.79
88430	26834	21.70	48.70	10.08	2.76	52.05	27.58	1.39	1.27	2.41	1.49	1.89
88431	26835	22.80	47.90	9.99	2.62	48.08	30.81	1.48	1.38	2.98	1.81	1.56
88432	26836	19.20	49.50	10.09	2.49	48.50	30.86	1.31	1.47	2.62	1.76	1.57
88434	26837	23.00	51.80	10.65	2.62	46.02	32.53	1.41	1.31	2.74	1.79	1.41
88435	26838	21.90	46.90	10.38	3.27	46.40	32.00	1.61	1.13	2.84	1.63	1.45
88437	26839	24.60	48.30	9.72	2.35	43.66	34.96	1.47	1.59	3.24	1.98	1.25
88438	26840	24.60	47.80	9.08	3.18	55.32	24.42	1.62	1.22	2.85	1.45	2.27
88439	26841	21.90	47.80	10.23	2.41	49.17	29.79	1.37	1.45	2.70	1.75	1.65
88440	26842	23.30	47.80	10.14	2.70	45.76	32.52	1.54	1.39	2.99	1.83	1.41
88441	26843	26.10	47.40	9.88	2.77	47.16	30.68	1.67	1.37	3.19	2.01	1.54

Breeder No	Lab No	Protein	Oil	Palmitic 16:0	Stearic 18:0	Oleic (O) 18:1	Linoleic(L) 18:2	Arachidic 20:0	Eicosenoic 20:1	Behenic 22:0	Lignoceric 24:0	O/L Ratio
						(%)						
86564	26844	23.70	50.00	9.46	3.93	50.28	26.88	1.99	1.25	3.86	1.60	1.87
CHANDRA	26845	24.50	46.20	9.54	2.41	50.21	28.82	1.38	1.58	3.09	1.80	1.74
87123	26846	24.10	47.90	10.89	2.45	38.35	38.63	1.50	1.64	3.23	1.95	0.99
88443	26847	20.40	47.80	10.78	2.39	47.37	30.90	1.41	1.56	2.84	1.80	1.53
88444	26848	24.00	46.10	9.81	1.80	50.87	27.71	1.19	1.85	3.37	2.22	1.84
88445	26849	20.30	47.90	10.00	2.27	51.03	28.92	1.30	1.46	2.66	1.58	1.76
88446	26850	20.30	52.80	9.30	3.16	51.87	27.42	1.63	1.31	2.80	1.57	1.89
88447	26851	18.80	48.70	11.30	2.38	47.01	31.83	1.26	1.21	2.44	1.66	1.48
88448	26852	22.30	45.30	10.42	2.12	48.17	31.00	1.29	1.51	2.87	1.83	1.55
88449	26853	19.30	47.60	10.31	2.25	44.78	33.21	1.35	1.60	3.26	2.11	1.35
88450	26854	22.40	45.20	9.21	3.07	54.02	26.12	1 62	1.22	3.00	1.28	2.07
88451	26855	18.80	50.30	10.09	2.74	48.79	30.55	1.47	1.22	2.79	1.44	1.60
88452	26856	19.10	47.50	10.45	2.69	47.43	31.40	1.34	1.35	2.65	1.70	1.51
88453	26857	23.90	46.60	9.82	2.65	48.19	29.99	1.50	1.44	3.09	2.00	1.61
88454	26858	24.20	47.70	10.71	2.49	44.48	32.43	1.54	1.49	3.32	2.08	1.37
88455	26859	20.60	49.00	10.16	2.99	46.54	31.75	1.60	1.26	2.89	1.72	1.47
88456	26860	24.00	49.50	9.65	2.69	43.05	34.66	1.67	1.48	3.56	2.21	1.24
88457	26871	21.70	47.60	10.10	2.47	47.54	30.98	1.44	1.45	3.06	1.88	1.53
88458	26862	24.80	48.70	10.05	2.57	46.13	31.82	1.53	1.49	3.19	1.95	1.45
88459	26863	22.70	44.50	9.16	2.13	41.73	38.21	1.42	1.48	3.02	1.67	1.09
88460	26864	19.60	48.30	9.71	3.11	47.99	29.40	1.71	1.42	3.99	1.92	1.63
88462	26865	24.00	44.50	9.13	2.25	42.96	37.06	1.43	1.53	3.12	1.80	1.16
88463	26866	18.80	49.60	9.68	3.01	47.40	31.43	1.72	1.37	3.19	1.59	1.51
88464	26867	23.40	47.60	9.83	2.89	49.53	28.92	1.61	1.33	3.54	1.66	1.71

Breeder No	Lab No	P... tero	G...	Pa... tic 16:0	Ste... ric 18:0	O... O) 18:1	Lino... leic(L) 18.2	Arac... hidic 20:0	Eicos... enoic 20:1	Behe... nic 22:0	Lignoc... ceric 24:0	O/L Ratio
							(%)					
88465	26868	23.20	49.10	10.28	2.53	45.28	33.94	1.44	1.31	2.71	1.76	1.33
88466	26869	25.80	42.80	11.59	2.60	40.14	37.37	1.48	1.22	3.08	1.64	1.07
88467	26870	21.10	49.50	10.92	3.30	47.00	30.54	1.69	1.12	3.17	1.50	1.54
88468	26871	26.30	46.00	11.63	3.86	39.99	35.36	1.95	1.15	3.03	1.79	1.13
88469	26872	18.00	49.60	10.22	2.60	49.02	30.99	1.36	1.24	2.51	1.43	1.58
88470	26873	20.10	47.00	10.12	2.51	48.56	30.58	1.41	1.35	2.92	1.74	1.59
88471	26874	18.50	48.30	10.64	3.56	45.26	31.57	1.87	1.19	3.61	1.56	1.43
88472	26875	25.00	50.00	9.15	3.35	49.95	27.71	1.84	1.41	3.96	1.82	1.80
88473	26876	23.60	49.00	9.61	3.49	48.96	28.16	1.89	1.25	4.23	1.81	1.74
88474	26877	23.10	50.80	9.56	3.78	48.95	27.92	2.04	1.20	4.24	1.66	1.75
88475	26878	19.70	51.40	9.89	4.18	48.33	28.19	2.16	1.18	4.30	1.56	1.71
88476	26879	23.10	48.80	9.95	3.65	49.61	28.07	1.80	1.26	3.56	1.47	1.77
88477	26880	22.40	47.70	9.96	3.90	49.04	28.01	2.01	1.17	3.82	1.53	1.75
88479	26881	25.40	45.80	10.89	3.48	45.50	31.31	1.81	1.28	3.60	1.60	1.45
88480	26882	20.70	45.30	11.20	3.80	46.68	29.93	1.78	1.14	3.51	1.52	1.56
88481	26883	22.40	44.60	10.92	2.90	44.16	32.72	1.66	1.49	3.59	1.86	1.35
88482	26884	23.60	47.30	9.97	3.12	48.21	29.66	1.69	1.34	3.52	1.70	1.63
88483	26885	19.90	51.40	11.99	2.55	39.52	37.40	1.46	1.40	3.07	1.76	1.06
88484	26886	24.20	44.30	13.74	2.38	36.21	40.35	1.46	1.17	2.52	1.51	0.90
88485	26887	17.90	51.70	11.31	2.96	41.70	36.25	1.57	1.30	2.85	1.55	1.15
88486	26888	20.90	48.90	11.03	3.14	40.91	35.74	1.76	1.31	3.74	1.65	1.14
88487	26889	17.50	53.80	10.36	3.39	46.65	30.52	1.86	1.44	3.60	1.61	1.53
88488	26890	19.40	51.30	10.52	3.53	46.38	30.49	1.88	1.33	3.60	1.58	1.52
88489	26891	23.80	44.70	10.98	3.08	45.77	32.53	1.55	1.18	2.78	1.65	1.41

Breeder No	Lab No	Protein	Oil	Palmitic 16:0	Stearic 18:0	Oleic (O) 18:1	Linoleic(L) 18:2	Arachidic 20:0	Eicosenoic 20:1	Behenic 22:0	Lignoceric 24:0	O/L Ratio
						(%)						
88490	26892	20.50	52.50	10.71	3.87	42.83	34.13	1.92	1.18	3.21	1.46	1.25
88491	26893	20.70	48.60	10.52	4.00	45.99	30.03	2.08	1.14	4.05	1.57	1.53
88492	26894	23.30	49.10	10.42	3.57	45.12	30.26	1.86	1.43	3.83	1.90	1.50
88493	26895	21.80	46.90	11.34	3.68	40.26	35.57	1.97	1.08	3.68	1.65	1.13
88494	26896	24.40	47.80	10.31	3.36	46.83	30.14	1.81	1.35	3.46	1.65	1.55
88495	26897	23.80	47.20	10.91	3.61	41.43	35.16	1.84	1.26	3.39	1.69	1.18
88496	26898	22.90	49.30	11.29	3.61	39.85	36.56	1.86	1.22	3.46	1.56	1.09
88497	26899	27.10	48.30	10.45	3.62	46.76	29.63	1.94	1.34	3.48	1.79	1.58
88498	26900	20.10	50.30	9.47	4.95	49.64	26.86	2.28	1.08	3.77	1.40	1.85
88499	26901	23.40	48.10	10.33	4.06	46.59	29.53	2.07	1.17	4.18	1.60	1.58
88500	26902	24.90	49.20	10.19	2.90	42.19	34.92	1.68	1.55	3.72	1.87	1.21
88501	26903	23.20	50.50	9.36	2.90	50.30	27.84	1.66	1.63	3.63	1.86	1.81
M 13	26904	25.00	45.80	9.75	2.05	49.03	30.25	1.28	1.79	2.97	2.00	1.62
CHANDRA	26905	24.60	45.70	9.77	1.99	48.75	30.58	1.24	1.69	3.20	1.93	1.59
86564	26906	21.70	48.10	9.65	4.00	49.79	27.10	2.03	1.23	4.16	1.60	1.84
87123	26907	22.50	48.10	11.04	2.17	37.16	40.38	1.40	1.81	3.29	2.00	0.92
JL 24	26908	26.90	45.90	12.08	2.90	36.59	39.02	1.70	1.24	3.73	1.73	0.94
89201	26909	19.70	52.70	9.57	4.29	51.42	26.26	2.03	1.05	2.99	1.43	1.96
89202	26910	23.50	47.80	10.75	2.68	43.32	34.11	1.58	1.44	3.38	1.75	1.27
89203	26911	18.40	42.70	11.67	2.37	43.22	34.41	1.53	1.41	3.02	1.64	1.26
89204	26912	20.00	48.30	10.19	3.79	48.04	28.82	1.90	1.28	3.59	1.57	1.67
89205	26913	19.50	46.90	9.94	4.27	49.04	26.82	2.18	1.17	4.26	1.50	1.83
89206	26914	23.30	49.80	10.48	3.00	42.68	34.61	1.71	1.47	3.41	1.75	1.23

Breeder No	Lab No	Protein	Oil	Palmitic 16:0	Stearic 18:0	Oleic (O) 18:1	Linoleic(L) 18:2	Arachidic 20:0	Eicosenoic 20:1	Behenic 22:0	Lignoceric 24:0	O/L Ratio
						(%)						
89207	26915	16.50	51.10	10.62	4.15	46.42	30.23	2.03	1.18	3.22	1.34	1.54
89208	26916	25.90	45.20	12.08	2.97	45.17	30.22	1.72	1.27	3.20	1.66	1.47
89209	26917	22.30	50.30	10.29	3.49	50.69	26.72	1.91	1.15	3.53	1.65	1.90
89210	26918	24.40	48.50	9.60	4.81	51.91	24.66	2.18	1.09	3.59	1.47	2.11
89211	26919	22.60	45.10	9.64	4.32	52.73	24.68	1.97	1.18	3.25	1.39	2.14
89212	26920	21.60	48.40	9.73	4.08	50.35	26.93	1.98	1.27	3.20	1.64	1.87
89213	26921	20.40	48.40	10.72	3.31	46.93	30.71	1.81	1.22	3.13	1.46	1.53
89214	26922	21.60	45.70	11.52	3.60	46.96	29.55	1.86	1.02	3.45	1.39	1.59
89215	26923	23.40	48.20	9.47	4.64	51.30	25.27	2.29	1.06	3.85	1.46	2.03
89216	26924	20.60	46.40	10.48	3.59	47.82	29.05	1.95	1.22	3.59	1.55	1.65
89217	26925	22.40	45.30	13.30	2.84	40.07	37.01	1.51	1.10	2.42	1.28	1.08
89218	26926	17.70	52.20	11.55	4.12	40.08	36.12	1.91	1.01	3.01	1.30	1.11
89219	26927	22.60	45.90	12.49	1.97	36.15	40.35	1.34	1.55	3.14	1.88	0.90
89220	26928	21.10	42.80	10.70	2.70	46.82	29.62	1.58	1.57	3.66	2.03	1.58
89221	26929	22.00	44.80	11.23	3.04	45.01	30.87	1.71	1.38	4.01	1.81	1.46
89222	26930	23.50	52.00	11.19	2.19	38.90	38.65	1.45	1.61	3.23	1.70	1.01
89223	26931	18.60	48.20	10.95	2.20	44.81	33.66	1.43	1.53	3.12	1.69	1.33
89224	26932	17.20	50.80	11.33	2.27	44.36	33.56	1.39	1.41	3.04	1.59	1.32
89225	26933	15.00	48.50	11.50	2.11	44.92	32.77	1.34	1.59	2.98	1.65	1.37
89226	26934	15.70	49.70	11.27	2.39	46.25	32.26	1.35	1.37	2.63	1.43	1.43
89227	26935	16.80	47.90	11.62	2.31	47.63	29.85	1.31	1.44	2.96	1.63	1.60
89228	26936	18.10	44.90	11.32	2.14	43.80	33.74	1.42	1.75	3.43	1.62	1.30
89229	26937	17.70	48.50	10.98	2.41	45.85	32.66	1.48	1.42	3.05	1.64	1.40
89230	26938	17.10	46.50	11.01	2.27	48.18	30.42	1.34	1.47	2.65	1.51	1.58

Breeder No	Lab No	Protein	Oil	Palmitic 16:0	Stearic 18:0	Oleic (O) 18:1	Linoleic (L) 18:2	Arachidic 20:0	Eicosenoic 20:1	Behenic 22:0	Lignoceric 24:0	O/L Ratio
						(%)						
89231	26939	17.50	50.20	10.12	2.49	49.77	29.07	1.49	1.56	3.04	1.44	1.71
89232	26940	16.50	50.80	11.51	2.12	44.70	33.02	1.33	1.46	2.98	1.74	1.35
89233	26941	20.00	48.00	10.63	2.27	43.20	34.41	1.46	1.59	3.54	1.74	1.26
89234	26942	17.90	46.60	11.32	1.99	37.59	39.59	1.36	1.55	3.48	1.79	0.95
89235	26943	17.40	49.50	9.55	2.87	52.94	26.57	1.64	1.31	3.16	1.23	1.99
89236	26944	18.30	49.70	10.68	2.35	47.56	31.57	1.40	1.40	2.86	1.63	1.51
89237	26945	22.30	42.30	12.67	2.87	32.81	42.80	1.65	1.13	3.12	1.78	0.77
89238	26946	17.00	49.80	11.07	2.32	44.17	33.64	1.47	1.38	3.12	1.59	1.31
89239	26947	18.10	48.40	11.41	2.25	42.02	34.90	1.44	1.49	3.41	1.70	1.20
89240	26948	18.00	50.80	10.74	2.65	44.32	33.94	1.54	1.41	2.97	1.54	1.31
89241	26949	16.90	49.10	11.39	2.79	45.08	32.44	1.58	1.28	3.27	1.41	1.39
89242	26950	18.60	48.80	10.94	2.23	46.22	32.14	1.40	1.44	3.11	1.65	1.44
89243	26951	16.20	45.70	12.23	2.14	39.86	36.86	1.40	1.46	3.02	1.68	1.08
89244	26952	19.20	47.80	10.91	2.15	43.30	34.89	1.41	1.60	3.06	1.83	1.24
89245	26953	19.60	46.50	10.66	2.12	42.73	35.03	1.39	1.65	3.23	1.82	1.22
89246	26954	17.80	47.60	10.77	4.14	46.47	28.83	2.17	1.11	4.30	1.36	1.61
CHANDRA	26955	22.40	47.00	10.40	2.12	44.93	33.13	1.37	1.74	3.29	1.79	1.36
86564	26956	21.90	48.00	9.86	3.73	48.61	27.88	1.95	1.29	4.29	1.66	1.74
ICGS 76	26957	23.40	45.50	10.03	2.23	49.59	29.27	1.29	1.68	2.97	1.80	1.69
Quality Studies Trial, ICRISAT Center, Postrainy Season 1988/89												
ICG 2411	26958	20.00	52.30	11.57	4.19	39.91	35.84	1.92	1.06	3.41	1.30	1.11
ICG 2411	26959	24.30	46.00	11.88	3.56	38.55	36.38	1.90	1.28	4.00	1.63	1.06
ICG 2411	26960	24.60	46.20	11.58	3.83	38.57	36.33	2.01	1.19	3.88	1.56	1.06

Breeder No	Lab No	Protein	Oil	Palmitic 16:0	Stearic 18:0	Oleic (O) 18:1	Linoleic(L) 18:2	Arachidic 20:0	Eicosenoic 20:1	Behenic 22:0	Lignoceric 24:0	O/L Ratio
						(%)						
ICG 7625	26961	19.90	52.90	11.51	2.54	41.97	35.35	1.55	1.30	3.21	1.65	1.19
ICG 7625	26962	21.60	48.10	12.00	2.33	39.99	36.19	1.48	1.49	3.63	1.86	1.11
ICG 7625	26963	21.90	50.30	11.61	2.56	41.66	35.68	1.55	1.39	3.12	1.63	1.17
ICG 7637	26964	19.00	53.70	10.05	3.34	51.33	28.13	1.59	1.14	2.77	1.21	1.82
ICG 7637	26965	23.60	50.80	9.84	3.00	51.18	28.10	1.63	1.30	3.01	1.37	1.82
ICG 7637	26966	24.80	47.20	11.32	1.83	40.45	37.44	1.24	1.92	2.96	2.08	1.08
ICG 1171	26967	23.00	44.80	11.61	3.24	38.84	38.61	1.62	1.16	3.19	1.42	1.01
ICG 1171	26968	25.00	44.80	11.54	3.01	37.76	39.10	1.56	1.18	3.27	1.44	0.97
ICG 1171	26969	25.70	45.10	11.66	3.18	38.52	38.40	1.60	1.13	3.20	1.40	1.00
ICG 6706	26970	20.70	48.10	11.19	2.92	37.91	38.71	1.57	1.42	3.50	1.68	0.98
ICG 6706	26971	23.70	47.00	10.93	3.36	39.49	37.37	1.73	1.29	3.30	1.67	1.06
ICG 6706	26972	28.50	44.50	10.70	3.23	38.97	38.01	1.78	1.36	3.33	1.76	1.03
ICG 3509	26973	24.60	47.10	10.95	3.00	38.05	38.36	1.69	1.47	3.51	1.75	0.99
ICG 3509	26974	22.70	48.00	11.01	2.95	38.23	38.83	1.66	1.50	3.56	1.70	0.98
ICG 3509	26975	28.30	45.00	10.77	3.21	38.69	38.33	1.72	1.33	3.54	1.79	1.01
ICG 6288	26976	20.80	48.00	10.50	3.82	39.96	36.80	1.79	1.26	3.31	1.47	1.09
ICG 6288	26977	27.80	46.00	10.13	3.44	39.95	37.20	1.74	1.29	3.38	1.65	1.07
ICG 6288	26978	27.70	44.70	9.99	3.51	40.37	37.21	1.83	1.37	3.37	1.62	1.08
ICG 8047	26979	25.70	46.80	10.32	3.63	39.82	37.33	1.77	1.30	3.43	1.64	1.07
ICG 8047	26980	23.70	47.00	10.33	3.58	40.13	37.03	1.77	1.38	3.36	1.59	1.08
ICG 8047	26981	26.60	46.20	10.28	3.53	39.61	37.12	1.79	1.32	3.56	1.66	1.07
ICG 5369	26982	20.70	48.30	9.54	2.33	49.70	29.73	1.38	1.73	2.94	1.68	1.67
ICG 5369	26983	20.20	46.90	9.77	2.30	48.50	30.57	1.43	1.83	3.16	1.69	1.59

Breeder No	Lab No	Protein	Oil	Palmitic 16:0	Stearic 18:0	Oleic (O) 18:1	Linoleic(L) 18:2	Arachidic 20:0	Eicosenoic 20:1	Behenic 22:0	Lignoceric 24:0	O/L Ratio
						(%)						
ICG 5369	26984	22.00	46.10	9.65	2.46	49.80	28.81	1.46	1.69	3.07	1.75	1.73
ICG 5856	26985	19.80	48.90	10.11	2.56	48.98	29.69	1.58	1.38	3.00	1.46	1.65
ICG 5856	26986	24.60	47.40	9.74	2.55	50.61	28.33	1.59	1.47	3.15	1.68	1.79
ICG 5856	26987	23.60	48.40	9.89	2.37	49.27	29.32	1.54	1.54	3.23	1.70	1.68
ICG 21	26988	17.20	49.00	10.01	2.79	49.29	29.25	1.53	1.56	3.01	1.48	1.69
ICG 21	26989	21.80	48.90	10.02	2.68	46.72	31.75	1.47	1.58	2.99	1.51	1.47
ICG 21	26990	22.20	48.30	9.84	2.26	45.89	32.90	1.42	1.86	3.29	1.79	1.39
JL 24	26991	23.20	48.50	11.89	3.37	36.80	38.57	1.80	1.26	3.44	1.45	0.95
JL 24	26992	27.00	47.00	11.74	3.02	36.63	39.29	1.76	1.25	3.42	1.43	0.93
JL 24	26993	27.90	46.30	11.86	3.20	37.09	39.08	1.76	1.20	3.32	1.53	0.95
ICGS 11	26994	22.40	46.90	11.18	2.49	37.18	39.40	1.53	1.77	3.33	1.87	0.94
ICGS 11	26995	23.10	44.90	10.93	2.29	36.84	40.10	1.48	1.82	3.40	1.92	0.92
ICGS 11	26996	23.60	48.20	10.75	2.39	37.21	39.72	1.53	1.77	3.37	1.89	0.94
ICG 2411	26997	18.90	52.80	12.88	3.58	39.45	36.30	1.78	1.03	3.49	1.14	1.09
ICG 2411	26998	17.50	52.90	12.65	4.00	38.72	35.66	2.04	0.94	3.74	1.23	1.09
ICG 2411	26999	18.30	51.00	12.63	3.96	37.81	36.07	2.10	1.07	3.96	1.27	1.05
ICG 7625	27000	20.60	50.80	12.31	2.19	39.26	36.27	1.56	1.63	4.17	1.82	1.08
ICG 7625	27001	22.70	51.10	12.17	2.22	39.30	36.62	1.51	1.52	3.59	1.86	1.07
ICG 7625	27002	21.30	51.50	12.06	2.14	39.40	37.07	1.50	1.54	3.58	1.70	1.06
ICG 7637	27003	17.20	52.70	10.88	3.06	46.98	30.34	1.71	1.35	3.43	1.27	1.55
ICG 7637	27004	18.40	49.40	11.44	2.58	46.16	30.31	1.65	1.55	4.02	1.43	1.52
ICG 7637	27005	19.50	51.00	10.91	2.92	48.67	28.89	1.70	1.48	3.62	1.37	1.68
ICG 1171	27006	20.30	47.20	12.50	2.99	36.35	39.03	1.75	1.17	3.70	1.48	0.93

Breeder No	Lab No	Protein	Oil	Palmitic 16:0	Stearic 18:0	Oleic (O) 18:1	Linoleic(L) 18:2	Arachidic 20:0	Eicosenoic 20:1	Behenic 22:0	Lignoceric 24:0	O/L Ratio
						(%)						
ICG 1171	27007	19.40	49.10	12.46	3.04	36.66	38.56	1.70	1.11	3.67	1.52	0.95
ICG 1171	27008	20.30	39.90	11.98	3.13	37.59	38.54	1.72	1.13	3.33	1.42	0.98
ICG 6706	27009	24.30	49.20	11.34	2.85	37.64	40.09	1.62	1.23	3.17	1.51	0.94
ICG 6706	27010	22.50	49.60	11.15	2.95	37.65	39.02	1.73	1.32	3.36	1.57	0.96
ICG 6706	27011	24.00	47.60	11.33	2.81	37.25	39.07	1.68	1.38	3.52	1.68	0.95
ICG 3509	27012	20.00	51.10	11.47	2.78	36.49	39.97	1.73	1.34	3.60	1.70	0.91
ICG 3509	27013	17.60	53.40	11.46	3.05	38.42	38.61	1.74	1.29	3.28	1.50	1.00
ICG 3509	27014	21.50	47.60	11.62	2.66	36.61	39.82	1.70	1.43	3.63	1.74	0.92
ICG 6288	27015	20.00	52.00	11.10	3.24	38.98	37.83	1.80	1.24	3.41	1.49	1.03
ICG 6288	27016	22.70	49.50	11.09	3.15	38.86	37.55	1.75	1.22	3.56	1.61	1.03
ICG 6288	27017	20.60	49.30	11.17	3.40	39.12	37.51	1.78	1.25	3.33	1.49	1.04
ICG 8047	27018	20.90	52.50	11.07	3.28	38.60	38.24	1.76	1.19	3.39	1.47	1.01
ICG 8047	27019	15.20	55.10	10.71	3.99	39.25	37.85	1.89	1.10	2.98	1.26	1.04
ICG 8047	27020	18.60	50.10	11.05	3.46	38.00	38.55	1.86	1.27	3.58	1.46	0.99
ICG 5369	27021	18.70	49.80	10.47	2.12	46.72	31.90	1.36	1.61	3.01	1.54	1.46
ICG 5369	27022	19.30	46.90	10.62	2.01	45.54	32.53	1.34	1.71	3.25	1.63	1.40
ICG 5369	27023	19.00	50.00	10.42	2.35	47.77	30.38	1.42	1.56	2.99	1.53	1.57
ICG 5856	27024	18.80	51.30	10.19	2.41	47.12	30.45	1.58	1.48	3.41	1.52	1.55
ICG 5856	27025	19.10	50.70	10.46	2.42	47.33	30.67	1.58	1.46	3.39	1.51	1.54
ICG 5856	27026	19.90	51.50	10.08	2.49	48.02	29.83	1.57	1.43	3.18	1.59	1.61
ICGS 21	27027	15.50	53.30	10.51	2.56	42.23	35.15	1.43	1.45	2.89	1.36	1.20
ICGS 21	27028	15.00	55.00	11.38	2.53	45.06	31.92	1.45	1.53	3.02	1.38	1.41
ICGS 21	27029	16.10	51.50	11.20	2.61	45.44	31.74	1.45	1.51	3.09	1.41	1.43
JL 24	27030	23.00	47.40	12.52	3.42	36.19	38.40	1.63	0.96	3.21	1.27	0.94

Breeder No	Lab No	Protein	Oil	Palmitic 16:0	Stearic 18:0	Oleic (O) 18:1	Linoleic(L) 18:2	Arachidic 20:0	Eicosenoic 20:1	Behenic 22:0	Lignoceric 24:0	O/L Ratio
						(%)						
JL 24	27031	23.20	49.20	12.57	3.43	36.44	39.05	1.71	1.00	3.19	1.26	0.93
JL 24	27032	24.10	49.20	12.74	3.10	36.36	39.14	1.65	1.03	3.22	1.37	0.93
ICGS 11	27033	19.80	49.30	12.09	2.02	36.56	38.70	1.37	1.60	3.34	1.75	0.94
ICGS 11	27034	15.80	51.60	12.58	2.19	35.78	39.70	1.40	1.55	3.02	1.71	0.90
ICGS 11	27035	20.30	47.90	12.10	1.95	36.68	39.49	1.38	1.73	3.28	1.88	0.93
ICRISAT Confectionery Groundnut Varieties, Bhavanisagar, Postrainy Season 1988/89												
86388	27036	23.80	50.40	12.41	2.91	45.58	29.42	1.73	1.39	3.38	1.56	1.55
87411	27037	24.60	48.00	11.91	2.72	46.12	29.93	1.57	1.44	2.92	1.65	1.54
87430	27038	20.00	49.40	12.54	2.75	45.44	30.09	1.55	1.36	3.03	1.48	1.51
87445	27039	22.80	46.00	16.45	1.90	38.73	35.96	1.32	1.77	3.46	1.79	1.08
87450	27040	23.40	46.10	13.77	1.53	37.59	36.20	1.20	1.88	3.29	2.04	1.04
87453	27041	22.60	46.80	13.44	1.78	44.99	30.41	1.28	1.82	3.18	1.83	1.48
87457	27042	23.30	45.20	10.51	2.76	52.72	23.96	1.53	1.67	3.29	1.77	2.20
87458	27043	23.20	47.30	13.31	2.75	35.01	38.83	1.60	1.33	3.42	1.75	0.90
87468	27044	24.70	48.60	12.42	2.27	40.87	33.94	1.46	1.62	3.14	1.94	1.20
87470	27045	21.00	48.40	10.39	2.64	53.01	24.84	1.49	1.58	3.18	1.64	2.13
86353	27046	19.30	49.80	10.10	2.90	53.12	23.80	1.59	1.45	3.12	1.51	2.23
87495	27047	25.10	49.40	12.15	3.01	41.02	33.61	1.81	1.25	3.32	1.67	1.22
86252	27048	25.30	48.40	13.36	1.77	38.56	35.76	1.27	1.82	3.08	2.08	1.08
86458	27049	24.20	46.50	13.02	1.97	44.77	30.76	1.23	1.58	2.75	1.57	1.46
86462	27050	24.60	52.50	12.79	1.99	40.90	33.63	1.37	1.80	3.29	1.98	1.22
86477	27051	23.50	46.10	12.58	2.24	36.99	37.88	1.51	1.65	3.56	2.03	0.98
86522	27052	24.40	45.20	13.12	1.86	44.28	31.44	1.24	1.68	2.92	1.74	1.41

Breeder No	Lab No	Protein	O:L	Palmitic 16:0	Stearic 18:0	Oleic (O) 18:1	Linoleic(L) 18:2	Arachidic 20:0	Eicosenoic 20:1	Behenic 22:0	Lignoceric 24:0	O/L Ratio
						(%)						
86436	27053	21.90	45.60	13.14	1.91	44.54	31.76	1.22	1.62	2.69	1.59	1.40
86518	27054	25.60	47.30	13.00	1.80	40.10	35.41	1.30	1.82	3.00	2.00	1.13
ICGS 11	27055	21.20	48.80	12.54	2.40	39.55	37.08	1.51	1.51	2.99	1.60	1.07
J 11	27056	24.90	47.40	13.07	3.40	39.03	34.07	1.82	1.06	3.75	1.41	1.15
ICG (FDRS) 4	27057	24.00	48.4	13.61	3.54	38.48	35.88	1.86	1.06	3.66	1.29	1.07
NCAC 343	27058	22.30	47.7	11.14	2.70	50.21	27.19	1.53	1.42	3.22	1.53	1.85
ICGV 86357	27059	23.60	48.1	11.36	2.33	45.9	30.66	1.49	1.67	3.35	1.98	1.50
86351	27060	21.70	48.60	13.27	2.06	42.27	34.01	1.34	1.58	2.83	1.88	1.24
86352	27061	23.60	48.7	12.69	2.01	41.88	33.32	1.30	1.62	2.97	1.84	1.26
86398	27062	24.00	46.80	14.05	2.59	38.97	36.39	1.48	1.30	2.59	1.48	1.07
86527	27063	23.80	48.30	11.09	2.55	48.68	27.80	1.50	1.49	3.16	1.75	1.75
86472	27064	18.50	49.30	9.69	3.63	58.76	19.22	1.81	1.28	3.16	1.33	3.06
86486	27065	22.70	47.90	11.14	2.36	48.07	28.82	1.43	1.65	3.16	1.58	1.67
86393	27066	22.70	48.10	13.91	1.95	38.82	37.00	1.21	1.60	2.99	1.71	1.05
86005	27067	21.80	48.20	12.82	3.24	42.11	33.27	1.70	1.18	3.14	1.64	1.27
86032	27068	24.40	48.00	12.39	2.37	38.88	36.69	1.47	1.39	3.39	1.96	1.06
86030	27069	24.10	45.70	11.03	2.51	50.12	25.04	1.56	1.76	4.02	2.03	2.00
KADIRI 3	27070	24.10	47.40	12.40	2.21	37.85	37.19	1.50	1.58	3.51	1.88	1.02
ICGS 5	27071	23.10	46.50	12.74	2.31	37.18	37.85	1.51	1.56	3.46	1.91	0.98
NCAC 343	27072	23.10	46.90	10.77	2.51	52.22	24.88	1.53	1.56	3.47	0.69	2.10

Breeder No	Lab No	Protein	Oil	Palmitic 16:0	Stearic 18:0	Oleic (O) 18:1	Linoleic(L) 18:2	Arachidic 20:0	Eicosenoic 20:1	Behenic 22:0	Lignoceric 24:0	O/L Ratio
						(%)						
Quality Studies Trial, Bhavanisagar, Postrainy Season, 1988/89												
ICG 2411	27073	19.60	51.60	12.87	3.83	38.33	35.68	2.04	1.08	3.89	1.31	1.07
ICG 2411	27074	22.50	51.40	13.45	4.33	40.93	33.28	2.01	0.94	3.45	1.28	1.23
ICG 2411	27075	22.30	50.60	13.30	4.14	39.95	33.64	2.05	1.01	3.75	1.33	1.19
ICG 7625	27076	24.90	50.50	12.31	2.53	43.12	33.05	1.56	1.38	3.19	1.65	1.30
ICG 7625	27077	23.50	52.00	12.44	2.61	43.27	33.18	1.61	1.34	3.05	1.61	1.30
ICG 7625	27078	22.50	52.90	12.00	2.67	42.97	32.69	1.62	1.26	3.41	1.63	1.31
ICG 7637	27079	21.60	49.30	12.71	2.44	40.54	35.09	1.48	1.33	3.31	1.74	1.16
ICG 7637	27080	20.00	52.90	13.05	2.73	40.69	35.26	1.463	1.32	2.92	1.67	1.15
ICG 7637	27081	22.30	50.20	13.41	2.41	39.71	36.06	1.46	1.39	3.17	1.68	1.10
ICG 1171	27082	22.90	46.40	13.22	3.52	38.96	35.69	1.84	1.05	3.52	1.48	1.09
ICG 1171	27083	25.70	45.80	13.37	3.46	37.40	36.69	1.79	1.05	3.33	1.56	1.02
ICG 1171	27084	23.60	47.10	13.18	3.42	38.61	34.76	1.76	1.07	3.69	1.58	1.11
ICG 6706	27085	27.10	46.40	11.66	2.99	38.27	36.41	1.80	1.33	3.84	1.81	1.05
ICG 6706	27086	26.70	48.10	11.86	3.24	38.51	36.95	1.85	1.22	3.43	1.88	1.04
ICG 6706	27087	28.60	48.00	11.87	3.09	38.75	36.68	1.74	1.11	3.16	1.87	1.06
ICG 3509	27088	23.60	49.80	11.69	3.44	40.21	35.42	1.88	1.14	3.18	1.60	1.14
ICG 3509	27089	28.60	48.40	11.73	3.32	39.74	35.16	1.79	1.10	3.02	1.72	1.13
ICG 3509	27090	23.30	48.90	11.50	2.68	37.57	39.15	1.64	1.33	3.64	1.74	0.96
ICG 6288	27091	25.80	46.80	11.65	3.30	41.68	33.73	1.90	1.25	3.73	1.77	1.24
ICG 6288	27092	22.70	51.50	11.59	3.97	40.92	34.00	1.99	1.07	3.46	1.46	1.20
ICG 6288	27093	23.60	50.30	11.41	3.93	41.42	33.59	2.09	1.11	3.44	1.53	1.23
ICG 8047	27094	25.00	49.30	11.61	3.29	39.53	35.82	1.84	1.24	3.47	1.62	1.10
ICG 8047	27095	25.80	49.40	11.84	3.66	40.46	35.43	1.81	1.07	3.14	1.50	1.14

Breeder No	Lab No	Protein	Oil	Palmitic 16:0	Stearic 18:0	Oleic (O) 18:1	Linoleic(L) 18:2	Arachidic 20:0	Eicosenoic 20:1	Behenic 22:0	Lignoceric 24:0	O/L Ratio
						(%)						
ICG 8047	27096	24.20	51.40	11.89	3.57	39.00	36.81	1.90	1.12	3.50	1.64	1.06
ICG 5369	27097	22.20	47.70	10.16	2.48	54.17	24.74	1.52	1.53	3.06	1.60	2.19
ICG 5369	27098	20.50	51.20	10.13	2.84	54.70	23.68	1.64	1.44	3.02	1.50	2.31
ICG 5369	27099	21.20	50.00	10.26	2.66	55.15	23.31	1.52	1.41	2.85	1.48	2.37
ICG 5856	27100	20.70	51.70	10.08	3.01	53.96	23.59	1.77	1.39	3.22	1.50	2.29
ICG 5856	27101	21.70	52.70	10.08	3.20	55.90	21.91	1.76	1.26	2.92	1.43	2.55
ICG 5856	27102	21.90	53.00	9.74	3.12	56.75	21.33	1.73	1.28	3.23	1.50	2.66
ICGS 21	27103	19.30	50.90	12.83	2.52	42.45	33.89	1.52	1.36	2.97	1.54	1.25
ICGS 21	27104	21.50	49.90	11.88	2.69	46.70	30.39	1.55	1.38	2.93	1.58	1.54
ICGS 21	27105	20.30	51.90	12.66	2.68	43.64	32.10	1.53	1.32	2.96	1.57	1.36
JL 24	27106	26.60	46.20	13.76	3.30	35.67	38.26	1.80	1.13	3.44	1.51	0.93
JL 24	27107	27.60	46.50	13.90	3.40	36.29	37.25	1.83	1.09	3.30	1.52	0.96
JL 24	27108	27.40	47.40	13.98	3.35	36.07	37.91	1.82	1.14	3.55	1.55	0.95
ICGS 11	27109	23.00	48.50	13.10	2.36	38.95	36.61	1.52	1.47	3.21	1.83	1.06
ICGS 11	27110	21.50	50.00	13.19	2.78	39.69	35.40	1.58	1.24	2.88	1.77	1.12
ICGS 11	27111	22.30	51.00	12.93	2.50	40.40	34.95	1.54	1.32	3.04	1.73	1.16

c:gn89.mem