Onderstepoort Journal of Veterinary Research,
Volume 25, *Number* 4, *December,* 1952.

The Government Printer, Pretoria.

THE INFLUENCE OF PROCESSING ON THE EFFICIENCY OF PROTEINS.

S. J. MYBURGH, J. G. LOUW AND J. W. GROENEWALD,
Onderstepoort Laboratory.

The marketing of balanced rations in the form of suitably compressed cubes or pellets has become increasingly popular. Claims are made that the subjection of feeds to heat treatment in the manufacturing of the cube renders it more digestible. In addition, the act of chewing cubes is considered to stimulate a greater flow of saliva as an aid to digestion. The advantages that practical feeders attribute to the use of cubes are that they are less dusty and that there is consequently less waste. Where proper mangers are available, however, there is no reason why the feeding of a balanced ration in the form of meal should prove wasteful. Whether the feeding of cubes or pellets would be preferred to meal, therefore, depends on local management facilities.

Cubes should not be too hard or too soft. Apart from the pressure used in cubing the correct fibre content and the addition of a small percentage of molasses are considered important as " binding " aids. Heat treatment of the molasses is essential in order to impregnate the cube. The temperature varies; some manufacturers employ mild heat, while others bring the molasses practically to boiling point.

In recent years many workers have given attention to the testing of proteins that have been subjected to heat in processing, especially in dehydration. Hayward (1936), Johnson (1939), Myburgh (1944), and Mitchell (1945), amongst others, found that mild heat treatment improved the proteins of soyabean. Achyara *et al.* (1942) maintained that a temperature of 132 to 136° C. improved the proteins of legumes and also those of some cereals.

On the contrary, other workers have shown that heat application may result in reduction of the protein digestibility and lowering of the biological value. Fairbanks (1935) showed that the " roller process " in milk dehydration resulted in a reduction of the efficiency of the proteins of milk. Chick *et al.* (1935) noted that whilst heating casein at 112 to 115° C. for 72 hours had no detrimental effect on the biological value of the protein, a temperature of 150° C. for 66 hours decreased the biological value from 64 to 44 (at 5 per cent. protein level in the diet), and reduced the digestibility from 93 to 73 per cent.

Henry (1947) maintained that " spray heating " of milk at a mild temperature of 190° F. (about 88° C.) did not cause deterioration of the protein and was comparable to milk dried at 160° F. (about 71° C.).

Received for Publication on 27th January, 1951.—Editor.

Furthermore, Greaves *et al.* (1938) found that lysine was the first heat-labile amino acid in the protein of casein at a temperature of 140° C. and that histidine was the second; cystine, tyrosine and tryptophane were unaffected by this temperature.

Cereal proteins were also damaged by heat application, according to Morgan (1931). A temperature of 200° C. for 45 minutes lowered the biological values of wheat and wheat gluten, but the digestibilities were only slightly affected. The same worker (Morgan, 1934) showed that a temperature of 85° C. for 7 minutes caused a slight lowering of the biological value of meat proteins.

Mitchell *et al.* (1945) concluded from their work on heat treated proteins that drastic heat application as generally used in commercial extraction of oil-bearing seeds may result in the destruction of heat-labile nutrients, such as the proteins. On the other hand, mild heat application for short periods had no detrimental effect, or improved the proteins; for instance a temperature of 75° C. in the case of cocoanut.

It is evident, therefore, that in the presence of heat a danger of protein deterioration does exist and may be marked in certain products.

The present report deals with the influence of mild heat processing on the digestibility and biological values of the proteins of two South African feedstuffs.

Experimental.

A firm of stock feed manufacturers kindly provided the feedstuffs used in this study. These consisted of a dairy meal and a fattening meal, together with cubes processed from the respective meals at a temperature not exceeding 80° C., cane molasses being used as a binder. The gross composition of the meals and cubes were as set out in Table 1.

Table 1.

The Composition of the Meals and the Cubes (in parts by weight).

Ingredients.	Dairy Meal.	Dairy Cubes.	Fattening Meal.	Fattening Cubes.
Maize Meal	45	45	135	135
Crushed Oats	10	10	10	10
Peanut Cake Meal	17·5	17·5	17·5	17·5
Linseed Cake Meal	2·5	2·5	2·5	2·5
Decorticated Cottonseed Cake Meal	2·5	2·5	2·5	2·5
Wheatbran	2·5	2·5	2·5	2·5
Palm Kernel Cake Meal	2·5	2·5	2·5	2·5
Lucerne Meal	2·5	2·5	2·5	2·5
Gluten Meal	3·0	3·0	3·0	3·0
Calcium Carbonate	0·5	0·5	0·5	0·5
Salt	0·5	0·5	0·5	0·5
Bone Meal	1·0	1·0	1·0	1·0
Molasses	0	10·0	0	10·0
Total	90·0	100·0	180·0	190·0
Per cent. Protein	18·6	17·6	15·2	15·5

In order to compare the digestibility and biological values of the proteins of the processed and unprocessed feedstuffs young albino rats were used as experimental animals, according to the nitrogen metabolism technique recommended by Mitchell, Hamilton and Beadles (1945). Six pairs of rats were used for a comparison between the proteins of dairy meal and of dairy cubes, and a similar number of animals of the same age and sex for that between the fattening meal and the fattening cubes. Details of the rations fed are given in Table 2.

TABLE 2.

The Percentage Composition of the Rat Rations.

Ingredients.	N-Low Ration.	Dairy Meal Ration.	Dairy Cubes Ration.	Fattening Meal Ration.	Fattening Cubes Ration.	Remarks.
Dairy Meal.....	—	48·4	—	—	—	
Dairy Cubes.....	—	—	51·0	—	—	
Fattening Meal.....	—	—	—	59·0	—	
Fattening Cubes.....	—	—	—	—	58·0	
Whole Egg.....	3·8	—	—	—	—	
Sucrose.....	10·0	—	—	—	—	
Butter Fat.....	8·0	8·0	8·0	8·0	8·0	Casein precipitated and filtered off.
Harris Yeast.....	2·0	1·0	1·0	1·0	1·0	
Cod Liver Oil.....	2·0	2·0	2·0	2·0	2·0	
Salt Mixture.....	2·0	2·0	2·0	2·0	2·0	Hubbel *et al.*
NaCl.....	1·0	1·0	1·0	1·0	1·0	
Dextrinized Starch...	69·2	37·6	35·0	27·0	28·0	
Agar.....	2·0	—	—	—	—	
TOTAL.....	100·0	100·0	100·0	100·0	100·0	
Per cent. Nitrogen.....	0·60	1·451	1·492	1·505	1·526	

RESULTS AND DISCUSSION.

By means of an analysis of variance the effects of the rations were compared in terms of apparent and true digestibilities and the biological value of the proteins.

Table 3 shows the means, and the necessary differences calculated on a 5 per cent probability level.

The nett protein values, depending on protein content, digestibility of the proteins and biological value of the digested proteins, have been calculated for the four feedstuffs and are presented in table 4.

From the data in table 3 it would appear that the proteins of dairy cubes were digested significantly better than the proteins of the dairy meal. This improvement in digestibility was presumably due to the heat treatment applied in processing. However, the treatment had no influence on the biological value of the proteins.

As may be expected the addition of 10 parts of molasses to 90 parts of dairy meal led to a reduction in the protein content of the resultant cubes. Reference to the figures for nett protein in the last column of table 4, however, shows that this reduction was more or less made good by the improvement in protein digestibility referred to above.

TABLE 3.

Comparison of the Digestibility and the Biological Value of the Proteins of the Rations.

Rations.	Apparent Digest.		True Digest.		Biological Value.	
	Mean.	Necessary Difference.	Mean.	Necessary Difference.	Mean.	Necessary Difference.
Dairy Cubes.....	74·2	—	86·5	—	67·3	—
Dairy Meal.....	71·4	—	83·7	—	67·2	—
Actual Difference.....	2·8**	1·9	2·8**	2·0	0·1	3·4
Fattening Cubes.....	73·0	—	84·7	—	67·5	—
Fattening Meal.....	74·0	—	85·8	—	67·9	—
Actual Difference.....	1·0	1·7	1·1	2·1	0·4	2·0

** Highly significant.

TABLE 4.

The Nett Protein Value of the Feeds.

Feed.	Protein Content %.	Digestibility of Protein %.	Content of Digestible Protein %.	Biological Value %.	Nett Protein %.
Dairy Meal.....	18·6	84	15·6	67	10·5
Dairy Cubes.....	17·6	87	15·3	67	10·2
Fattening Meal.....	15·2	86	13·1	68	8·9
Fattening Cubes.....	15·5	85	13·2	67	8·8

Inspection of the relevant data reveals that the method of processing had no significant effect on the digestibility or biological value of the proteins of the fattening meal. In view of the result obtained with the dairy meal in respect of digestibility this finding may mean that the proteins of maize, of which the fattening meal contained a much greater percentage than the dairy meal, were less affected by the processing than the proteins of the other ingredients of the feedstuffs.

SUMMARY.

Employing an improved nitrogen balance method the influence of mild heat treatment on the digestibility and biological value of a mixure of plant proteins has been determined.

The heat treatment resulted in a small though significant improvement in the digestibility of the proteins. Protein quality was, however, not affected.

ACKNOWLEDGMENTS.

The writers wish to thank Dr. P. M. Oosthuizen, formerly of the Agricultural Research Institute, Pretoria, for his kind assistance in providing the feedstuffs, as well as giving the required information in regard to their composition and processing.

Furthermore, we express our appreciation towards Mr. D. van der Reyden of this Institute for the statistical analysis of the results.

REFERENCES.

ACHARYA, B. N., NIYOGI, S. P., PATWARDHAN, V. N. (1942). The effect of parching on the Biological Value of the Proteins of some Cereals and Pulses. *Indian J. Med. Res.* Vol. 30, p. 73.

BLOCK, R. J. AND MITCHELL, H. H. (1946-1947). The Correlation of the Amino Acid Composition of Proteins with their Nutritive Value. *Nutr. Abst. and Revs.* Vol. 16, p. 268.

CHICK, H., HUTCHINSON, J. C. D. AND JACKSON, H. M. (1935). The Biological Value of Proteins. VII The Influence of Variation in the Level of Protein in the Diet and of Heating the Protein on its Biological Value. *Biochem. J.* Vol. 29, pt. 2, p. 1712.

FAIRBANKS, B. W. (1935). The Nutritive Value of Skim-milk Powders with special reference to the Sensitivity of Milk Proteins to Heat. *J. Agric. Res.* Vol. 51, pp. 1107-1121.

GREAVES, E. O., MORGEN, A. F. AND LOVEEN, M. K. (1938). The Effect of Amino Acid Supplements and of Variations in Temperature and Duration of Heating upon the Biological Value of Heated Casein. *J. Nutrition.* Vol. 16, p. 115.

HAYWARD, J. W., STEENBOCK, H. AND BOHSTEDT, G. (1936). The Effect of Heat as used in the Extraction of Soya Bean Oil upon the Nutritive Value of the Protein of Soya Bean Oil Meal. *J. Nutrition.* Vol. 11, p. 219.

HENRY, K. M. AND KON, S. K. (1947). A note on the Effect of the Temperature of Pre-Heating of Spray Dried Whole Milk on Biological Value of its Protein. *J. Dairy Res.* Vol. 15, Nos. 1 and 2, p. 140.

JOHNSON, L. M., PARSONS, H. T. AND STEENBOCK, H. (1939). The Effect of Heat and Solvents on the Nutritive Value of Soya Bean Protein. *J. Nutrition.* Vol. 18, p. 423.

MARAIS, J. S. C. AND SMUTS, D. B. (1940). The Biological Value of the Proteins of Maize and Maize Supplemented with Lysine and Tryptophane. *Onderstepoort J.* Vol. 15, Nos. 1 and 2, p. 197.

MITCHELL, H. H. AND BLOCK, R. J. (1946). Some Relationships between the Amino Acid Contents of Proteins and their Nutritive Value for the Rat. *J. Biological Chemistry,* Vol. 163, No. 3, p. 610.

MITCHELL, H. H. AND CARMAN, G. G. (1924). The Biological Value of Maintenance and Growth of the Proteins of Whole Wheat, Eggs and Pork. *J. Biological Chemistry.* Vol. 60, p. 613.

MITCHELL, H. H., HAMILTON, T. S. AND BEADLES, J. R. (1945). The Importance of Commercial Processing 1. Soybean, Cocoanut and Sunflower Seed. *J. Nutrition.* Vol. 29, p. 13.

MORGAN, A. F. (1931). The Effect of Heat upon the Biological Value of Cereal Proteins and Casein. *J. Biological Chemistry.* Vol. 90, p. 771.

MYBURGH, S. J. (1944). The Nutritive Value of the Protein of a few South African Soybean Meals. *Onderstepoort J.* Vol. 19, Nos. 1 and 2, p. 161.