Pertanika 12(1), 33-41 (1989)

Determination of Meat Content in Processed Meats Using Currently Available Methods

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Key words: Meat content; methods; processed meats.

ABSTRAK

Empat kaedah digunakan dalam penentuan kandungan daging dalam produk daging terproses. Kaedah yang dirujukkan sekarang tidak begitu tepat dan payah diguna untuk pemonitoran mutu kandungan daging. Satu kaedah yang tepat dan praktikal diperlukan untuk menentukan kandungan daging dalam produk daging terproses. Kaedah analisis pigmen jumlah dan mioglobin didapati lebih sesuai untuk penentuan kandungan daging pada burger lembu tempatan, jika dibandingkan dengan kaedah Pearson (1975) atau Stubbs & More (1919).

ABSTRACT

Four methods were used in the determination of meat content in local meat and meat products. Current methods available are not reliable and applicable to routine monitoring and quality control by the regulating laboratories as well as the meat processing industry. A reliable and practical method is needed to monitor meat products and ensure that they are meeting the minimum requirement of sixty five (65%) percent meat content. The total pigments and myoglobin technique was found to be applicable for determination of meat content in locally processed beef burgers, when compared to the Modified Method of Stubbs & More (1919), and Pearson Method (1975).

INTRODUCTION

There has been a significant increase in the production of value added meat products and their selection in the chilled and frozen sections of major supermarkets in Malaysia. In 1983 the value of processed food originating from livestock exceeded 1,600 million Malaysian Ringgit. Malaysia is expected to import about 426,902 beef cattle to provide for 32,000 ton of beef by the year 1990 (Idrus 1981). Currently, the country uses about 114,500 ton per year, valued at about 300 million Ringgit (Malaysian Business 1980). Processed meats, especially hamburgers and frankfurters are common food items to many people in Malaysia as can be seen by the many fast food chains and local burger stands. In the U.S.A., a hamburger is defined as chopped/minced meat with or without added fat and spices (de Holl 1976). It should also contain not more than 30% fat. Wilson *et al* (1981) described burger to contain 80% meat with the rest comprising cereal, water binding materials, flavours and spices. In Malaysia, there is no clear definition and specifications for burgers. Manufacturers in their efforts to cut cost, often use meat substitutes such as cereals, soya proteins, groundnuts and lately mechanical deboned meat to formulate the hamburgers and frankfurters. The problem is: how does one goes about quantifying meat content in such products, so that consumers can be assured that such products contain a minimum of 65% meat as stipulated by the Food Law and Regulation (1985). A recent development in the import of beef should also be mentioned in this content. Most beef was imported from Australia until 1983, when the government decided to open its meat market to India. Today, due to its lower price, much of the beef (more than 90%) is imported from India, usually from the fore quarters. It is cheaper than even the imported soya isolate and concentrate, which would lead one to think that manufacturers would use more meat (at least 65%) so as not to contravene the food regulation. But this is not so. Instead, manufacturers go for formulations consisting of Indian beef (40-60%), soya proteins (10-30%), wheat/tapioca flours, mechanically deboned meat and egg proteins to come up with the least cost. Soya protein is popular because of its high waterholding capacity, good texture, and bulkiness in weight when hydrated. Therefore, in today's beef burger, the two major components are Indian beef and soya protein concentrate. This paper is aimed at discussing currently available methods for quantifying meat in such products and their usefulness in routine quality control checks for the minimum requirement of 65% meat content for regulating purposes.

MATERIALS AND METHODS

Local beef type D (fresh cut) from class 'Bull' or Cow were purchased from a local market. Indian Beef (deboned) type F, forequarter was purchased from a local meat processing company. Local beef burgers (12 brandnames) were obtained from the supermarkets. All meat samples were completely homogenized, stored in airtight bottles in a freezer at -20°C until ready for analysis.

Standard Beef-Soya Cereal Blend

Beef soya protein cereal blends were prepared to test the accuracy and percent recovery using methods currently available. The seven blends prepared were as follow:

	Indian Beef (80:20)	SPC (1:2)	Wheat flour
A	100	0	0
B	90	5	5
C	80	15	5
D	70	25	5
E	60	35	5
F	50	45	5
G	40	55	5

Total protein from such blends would include meat protein, soya protein and gluten protein. For calculation of meat protein, a correction formula as suggested by Pearson (1975) was used.

Meat protein = Total Nitrogen – ($KaC + K_bS$) x 6.25 where

Ka = conversion factor of cereal to nitrogen
C = total cereal measured
Kb = conversion factor of soya proteins to nitrogen
S = total soya measured.

In this study a 70% protein content soya concentrate was hydrated with 2 parts water making a Kb value equal to $0.7 \times 1/3 \times 1/5.71 = 0.0409$. Ka is given a value of 0.02×0.69 with the assumption of cereal (wheat) containing 69% carbohydrate and 2.0% nitrogen (Pearson 1975).

Determination of Total Pigment in Meat, Burger and Blend Standards (Rickansrud & Henrickson, 1967)

A 25g sample was blended in 100ml distilled water for 3 minutes. The homogenate was centrifuged at 2000 x g at 6°C for 15 minutes using the MSE Coolspin Centrifuge. The supernatant was filtered through 3 whatman filter paper. The precipitate was mixed with another 100ml distilled water, centrifuged again and filtered to finally obtain a 200ml of homogenate solution.

A 20ml aliquot was pipetted into a 50ml Erlenmeyer flask and 4mg potossium ferricyanide added. Total pigment concentration in mg/g (wet weight) was calculated from absorbance reading at 540nm using a Bausch and Lomb Spectronic 20. For fresh meat samples calculations were made based on wet weight, dry weight, wet weight fat free basis and dryweight fat free basis.

Calculation for total pigment was obtained using the formula:

Conc total pigment in mg/g wet weight

$$= \frac{\text{Absorbance} \times K}{\text{wet weight sample}}$$

where

$$K = \frac{17{,}000 \times \text{aliquot vol (L)} \times \text{dilution factor}}{E}$$

and E = Coefficient extinction myoglobin
= 11.3 nM/L

Determination of Myoglobin Content Using the Poel-Cyano Method (Topel, 1949)

The pH of meat samples was determined using the AOAC method (1980). A 10g sample was homogenized for 2 minutes in cold water mixed with X ml INH_2SO_4 in a waring blender.

$$X = (pH \text{ sample } -5) \times 0.35$$

The homogenate was centrifuge at 3000 rpm for 2 minutes in a polyethylene tube (50ml) using the MSE Desk centrifuge. The supernatant obtained was transferred to a 50ml tube and heated slowly to reach a temperature of 54°C after which it was soaked in a water bath to reach 25°C. The homogenate was placed in a 100ml beaker and the pH brought to 7.2 using $Na_2 CO_3$. The homogenate was transferred back to a 50ml tube and centrifuged for 10 minutes at 2500 rpm. The supernatant was filtered into a 50ml Erlenmeyer flask and 2-3 small crystals of potassium ferricyanide added. Absorbance was read at 540 nm using the Spectronic 20.

Calculation of myoglobin (Mb) derived by Poel-Cyano (Topel, 1949):

$$\text{mg Mb/g wet tissue} = \text{absorbance} \times 7.50$$

Results were expressed in mg/g wet weight for burger samples and the blend standards, while for fresh meat samples, calculations were made on dry weight, dry weight fat free basis and wet weight fat free basis.

Methods Used for Quantitation of Meat Content Using Myoglobin Content as an Index The Poel-Cyano (Topel 1949) described above was used to quantitate meat content. Calculation was made on a fat free dry weight basis to avoid the wide variation in fat distribution as well as added fat in the samples.

Calculation:

$$\text{Fat free meat} = \frac{\text{myoglobin content (mg/g)}}{f_1}$$

where f_1 = conversion factor myoglobin in meat, i.e. amount of myoglobin in 100% Indian beef calculated in mg/g fat free weight basis

= 4.93 mg/g

Total meat content meat (fat free) and fat content.

The conversion factor for myoglobin to fat free meat (f1) is obtained from our analysis of myoglobin content in Indian beef. This is because most meat producers use Indian beef as the meat component.

Using Total Pigment Content as an Index The total pigment content was determined from an analysis of the meat commonly used for beef burger processing, i.e. Indian beef.

Total pigments was expressed in mg/g for free basis to avoid high variation from fat present or added to beef burgers.

Calculation:

Total Pigments of fat free meat

$$= \frac{\text{total pigments content (mg/g wet wt)}}{f2}$$

where f2 = conversion factor of total pigments in meat i.e. amount of total pigment in 100% Indian beef calculated in mg/g fat free weight basis

= 6.31mg/g

Total meat = meat fat free + fat content

Quantitation of Meat Content Using Modified Method of Stubbs and More (1919) The original formula by Stubbs and More (1919) does not account for nitrogen coming from cereal or soya proteins. The conversion factor of nitrogen to meat is 3.55 for beef (Analytical Committee 1963) and is reported on fat free basis. Pearson (1975) stated that correction is necessary for total nitrogen if there is cereal inclusion. In this paper, total nitrogen is corrected for cereal and soya protein.

Assuming cereal is from wheat:

$$\% \text{ cereal nitrogen} = KaCr$$

where Cr = cereal content (AOAC, 1980) in %

Ka = conversion factor to nitrogen

= 0.02 x 0.69 with assumption cereal contained 69% CH_20 and cereal wheat contained 2% nitrogen (Pearson, 1975)

Assuming soya protein as the major non-meat protein

% soya nitrogen = KbS

where S = Soya protein conc. (70% protein, 1:2 soya:H_2O (H_2O)

Kb = conversion factor to nitrogen
= 0.70 x 1/3 x 1/5.71
= 0.0409

∴ meat nitrogen (fat free)

$$= \frac{100\ Nt - KaCr - KbS}{F}$$

where,

Nt = total nitrogen

KaCr = nitrogen from cereal

Kbs = nitrogen from soya

F = %fat

Total meat = meat (fat free) + fat

Quantitation of Fat Free Meat Using Modified Pearson Method (1975) In some countries meat (fat free) is used to indicate meat content in meat products. Pearson (1975) put forward some formulas for calculating fat-free meat, the most common being:

$$\text{meat (fat free)} = \frac{100Nt - FeNm\ \frac{(100-1)}{Ff} - (KfC)}{Nm\ (1 - F1/Ff)}$$

where

Nt = % total nitrogen in product

Fe = % extracted fat

Nm = 3.55, conversion factor nitrogen to beef

Ff = % extraneous fat max 90%

Fl = % intramuscular fat max 10%

Kf = % nitrogen in cereal, calculated on dry CH_2O basis

C = % carbohydrate in product

An adjustment is needed in the above formula to take into account the nitrogen contribution from soya protein in a beef-soya-cereal added beef burgers.

Therefore

meat (fat free) or lean meat, LM;

$$LM = \frac{100\ Nt - FeNm\ \frac{(100-1)}{Ff} - KfC - KaS}{Nm\ (1 - Fl/Ff)}$$

where S= % soya protein conc. (70%) protein hydrated 1:2 (SPC: H_2O)

Ka = % nitrogen in soya protein conc.
= 0.70 x 1/3 x 1/5.71

Statistical Analysis

Analysis of Variance (ANOVA), F Values, and DMR tests were used in data processing, using the Statistical Analysis System (SAS).

RESULTS AND DISCUSSION

A proximate analysis was done on various meat cuts commonly used in the meat industry. For comparison purposes, we have included heart tissue, sirloin cut, Indian beef (imported) and also mechanical deboned beef (MDB). Table 1 shows the major components from various meat cuts and sources. Protein content ranged from 20-30%, with MDB at 4.5% protein. The fat content ranged from 1.4-8.4% with MDB at 16.8%. Water content for most cuts is about 75% and ash varies from 0.83-1.34%. Indian beef contained very little fat (1.4%), a factor, which should be noted for several reasons later. The composition of MDB is also different than normal meat cuts, fat (16%), protein, (4.5%) and ash at 2.80%. Its utilisation in locally processed meat is increasing and therefore should be monitored.

The wide variation in meat components must be considered in methodologies for meat content determinatin. Pearson (1975) in his formulation for lean meat suggested fat level not exceeding 10%, when determining lean meat. Muscle fat has been reported to range from 1-18%. In this study the fat content ranged from 1.4 - 8.4%.

Concentration of Pigment in Meat

Total pigment and myoglobin contents were determined in local meat cuts commonly used in processing. Although myoglobin comprises three fractions, with different absorptions, Rickansrud & Henrickson (1967) noted that these differences can be obstructed by converting them into the cyanmetmyoglobin form. Table 2 shows the concentration of myoglobin in local meat cuts on wet weight, and dry weight

TABLE 1
Proximate composition of various meat cuts (lean)

Meat Cuts[1]	Protein %	Fat %	Moisture %	Ash %
IB[2]	20.0[bc]	1.4[de]	76.3[a]	0.83[ef]
MDB[3]	4.5[d]	16.8[a]	76.2[a]	2.86[a]
MBC	18.9[c]	4.1[cd]	75.0[a]	1.04[cd]
MBT	21.5[ac]	8.4[b]	72.5[a]	1.04[cd]
MBB	20.0[bc]	3.8[cd]	77.3[a]	1.12[c]
MBS	20.0[bc]	5.1[c]	76.5[a]	0.87[def]
MBFC	21.6[ab]	2.1[de]	76.2[d]	1.02[cde]
MBFT	22.7[a]	4.1[cd]	74.9[a]	0.78[f]
MBFB	22.6[a]	1.9[de]	74.5[a]	1.34[b]
MBFS	23.0[a]	1.5[de]	75.5[a]	0.90[def]
MBH	20.3[bc]	0.3[e]	78.4[a]	1.01[cde]

[1]Means of 2 samples IB = Indian Beef
[2]Means of 6 samples MDB = Mechanical Deboned Beef
[3]Means of 3 samples MBC = Malaysian Beef, Chuck
MBT = Malaysian Beef, Trimming
MBB = Malaysian Beef, Brisket
MBS = Malaysian Beef, Sirloin
MBFC = Malaysian Buffalo, Chuck
MBFT = Malaysia Buffalo, Trimming
MBFS = Malaysian Buffalo, Sirloin
MBH = Heart Muscle

Means with different superscripts within each column indicate significant differences ($P < 0.05$)

TABLE 2
Myoglobin content of selected meat cuts (lean)

Meat Cuts[1]	Wet weight	Dry weight	Wet fat free	Dry fat free
	mg/g	mg/g	mg/g	mg/g
IB[2]	4.86[bcd]	20.38[bc]	4.93[b]	21.66[bcd]
MDB[3]	6.19[ab]	26.02[ab]	7.44[a]	88.69[a]
MBC	4.25[cdef]	17.32[cde]	4.44[bc]	22.13[bcd]
MBT	3.23[ef]	11.78[e]	3.53[bcd]	17.02[cd]
MBB	2.78[f]	12.34[de]	2.90[d]	15.15[d]
MBS ·	4.76[bcd]	20.28[bc]	5.02[b]	25.96[bc]
MBH	6.38[a]	29.91[a]	6.47[a]	30.19[b]
MBFC	4.30[cde]	18.07[cd]	4.40[bcd]	19.82[bcd]
MBFT	3.40[def]	13.88[de]	3.34[cd]	16.36[cd]
MBFB	3.25[ef]	12.95[de]	3.32[cd]	14.05[d]
MBFS	4.92[bc]	20.08[bc]	5.00[b]	21.40[bcd]

1 = Means of 2 samples
2 = Means of 6 samples
3 = Means of 3 samples

Means with different superscripts within each column indicate significant differences ($P < 0.05$).

on a normal and fat free basis. Myoglobin content from sirloin cuts of beef and buffaloes are higher when compared to other cuts. Rickansrud and Henrickson (1967) reported similarly high values in *longissimus dorsi* muscles. Heart tissue had 6.38 mg/g of myoglobin while deboned beef had 6.19 mg/g of myoglobin. Indian Beef had 4.86 mg/g while local buffalo brisket trimmings and chuck ranged from 2.78-4.30 mg/g. Indian beef (Buffalo, Type F) seemed darker in colour when compared to local beef cuts. The mean value of myoglobin concentration for all cuts is 4.03 mg/g with standard deviation of 1.11 mg/g.

A detailed study was investigated on the myoglobin content of Indian Beef. This was in view of the fact that most manufacturers used Indian Beef as a major component in burger production. Adjustment of meat on a lean, dry weight basis reduced the coefficient of variation, (Appendix 1) from 23.78% and 23.80% to 20.11 and 20.13% respectively. Thus it is better to express the content of myoglobin on a dry weight basis. A total of six samples of Indian beef were analysed to obtain a mean value for myoglobin concentration that is reliable for use as a reference. The concentration mean of 4.93 mg/gm on fat free basis wet weight basis was chosen, because of the variable fat content in various meat cuts and the fact that added fat is part of the burger formulation in most instances.

The total pigment content in loal beef cuts ranged from 3.90-5.36 mg/g, local buffalo, 3.96-5.27 mg/g; Indian Beef, 6.23 mg/g and beef heart, 7.55 mg/g. (Table 3). Total pigment includes hemoglobin, myoglobin, cytochrome, vitamin B12, heme pigment and flavour. It should be noted that 95% of the iron in a piece of meat is in the myoglobin component (Clyesdale and Francis 1976). Other factors like genetics, muscle types, and handling during preslaughter could affect the pigment content in meat. (Rosenman & Morrison 1965, Brown 1962, Livingstone & Brown 1980).

In using total pigment as an indicator of meat content, it was observed that total pigment on a fat free dry weight basis resulted in the lowest coefficient of variation, (18.33%, Appendix 1). With total pigment, the conversion factor used to obtain meat content was based on fat free wet weight basis of 6.31 mg/g.

TABLE 3
Total pigments content in selected meat cuts (lean)

Meat Cuts	Wet weight	Dry weight	Wet weight fat free	Dry weight fat free
	mg/g	mg/g	mg/g	mg/g
IB	6.23[ab]	22.70[ab]	6.31[ab]	27.78[bc]
DNM	6.54[ab]	27.50[ab]	7.86[a]	93.78[a]
MBC	5.13[bc]	20.82[ab]	5.33[bc]	26.47[bc]
MBT	4.82[bc]	17.58[b]	5.26[bc]	25.38[bc]
MBB	3.90[c]	17.33[b]	4.06[c]	21.26[c]
MBS	5.26b[c]	22.38[ab]	5.54[bc]	28.66[bc]
MBH	7.55[a]	32.36[a]	7.58[a]	35.47[b]
MBFC	4.92[bc]	20.67[ab]	5.02[bc]	22.68[bc]
MBFT	3.96[c]	16.30[b]	4.14[c]	19.16[c]
MBFB	4.12[c]	16.45[b]	4.20[c]	17.87[c]
MBFS	5.27b[c]	21.50[ab]	5.35[bc]	22.90[bc]

Means with different superscripts within each column indicate significant differences ($P < 0.05$).

The determination of total nitrogen is not able to give an indication of how much meat is in the mixed products such as hamburgers. This is shown in Table 4. However, data from Table 4 and *Figures 1* and *2* showed a strong correlation between meat content and myoglobin and total pigment contents.

Determination of Meat Content in Soy-Beef Standard and Local Beef Burgers.

Three methods were described earlier in the Methods and Materials section. A standard mix-ture of meat soy patties was formulated to test recovery and accuracy of the methods used.

Table 5 shows the recovery of meat from beef-soy mix standard, using myoglobin, total pigments and Mg as indicators. The recovery rate (means and standard deviations) are 97.6 ± 6.2, 96.6 ± 6.87 and 107.4 ± 12.5% respectively. Thus both myoglobin and total pigments are similar when used as indicators for testing recovery of meat content. The Mg method by Stubbs and More (1919) is more variable, due to Mg being contributed from other sources than just meat itself. Table 6 shows the Mg, myoglobin and total pigment contents in local beef burgers. The values of meat recovered using the pigments, Mg and a modified Pearson (1976) methods for meat quantification in local beef burgers is shown in Table 7. The contents of meat ranged from 22.3%-65% (myoglobin as index) 23.5-71.1% (total pigments as index); 26.7-71.7% (Mg as index) and 12.3-53.9% (with modified Pearson method). From these methods, it can be concluded that myoglobin and total pigments are reliable indicators to use for quantification of meat in mix products such as beef burgers and frankfurters.

Stubbs and More's (1919) method using magnesium is not reliable because of the presence of the element in soy protein and spices, which are commonly used in meat products formulation these days. The weaknesses of the modified Pearson Method (1975) which is based on Stabbs and More, has been discussed earlier.

TABLE 4
Total nitrogen and pigment concentration in standard beef-soya-cereal mix

Standard	Beef soya cereal Mix[1,2] (%)	Total nitrogen (%)	Myoglobin (mg/g)	Total pigment (mg/g)
A	100 – 0 – 0	2.64	3.68	4.72
B	90 – 5 – 5	2.65	3.38	4.28
C	80 – 15 – 5	2.54	3.23	4.04
D	70 – 25 – 5	2.67	2.74	3.51
E	60 – 35 – 5	2.71	2.33	2.90
F	50 – 45 – 5	2.73	1.91	2.31
G	40 – 55 – 5	2.72	1.52	1.90

1 Meat is 80% Indian Beef (lean) and 20% fat
2 Textured soya protein

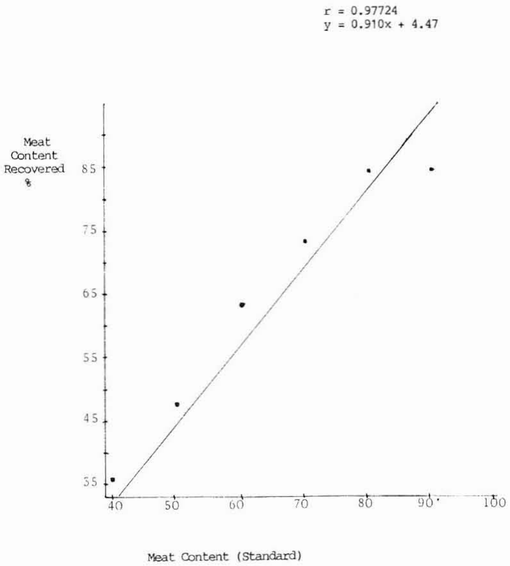

Fig. 1 : Regression curve showing meat content recovered from beef-soya standard mix using myoglobin as an indicator.

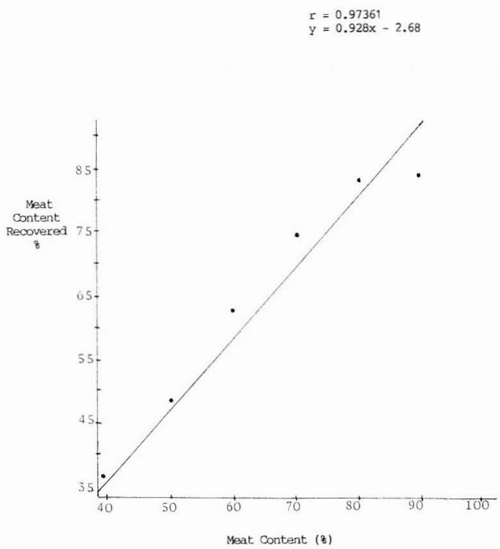

Fig. 2 : Regression curve showing meat content recovered from beef-soya mix using total pigments as indicator.

TABLE 5
Recovery of meat from beef-soya standard

Standard	Meat[1]	Meat[2]	Meat[3]
A	92.5	92.7	92.0
B	91.2	90.3	94.1
C	103.5	101.6	105.9
D	102.0	103.8	117.0
E	106.0	103.8	127.5
F	96.0	91.8	111.4
G	91.8	90.0	104.25
Mean,%	97.6	96.6	107.4
Standard deviation, %	± 6.2	± 6.87	± 12.5
Range, %	91.8-106	90.0-105.8	92.0-127.5

[1] Using myoglobin as an indicator
[2] Using total pigments as an indicator
[3] Stubbs & More (1919) Method.

CONCLUSION

Methods using myoglobin and total pigments can be used to quantitate the meat content in meat products. Its inherent variability in meat tissue is well defined but its conversion to cyanmetmyoglobin form in this procedure reduces its heterogenous variability. Myoglobin is only present in meat tissues and is more reliable than total pigments, which contains hemoglobin and which could be contributed from blood. Although the amount of myoglobin varies with different muscle types, for instance, it is higher in heart muscle, the amount is less variable in

TABLE 6
Magnesium, myoglobin and total pigments contents in local beefburgers

Brandnames[1]	Magnesium (ppm)	Myoglobin (mg/g)	Total Pigment (mg/g)
FIKA	240[d]	2.03[b]	3.10[b]
ANGUS	353[ab]	1.76[cd]	2.25[c]
RAMLY	231[d]	2.12[b]	2.81[c]
WISMA BURGER	286[cd]	2.03[b]	2.72[cd]
PRINCE	295[bcd]	0.39[h]	0.5[h]
BIFFI	352[ab]	1.18[f]	1.53[f]
KB	390[a]	1.43[e]	2.10[e]
AMIRUL	351[ab]	0.83[g]	1.26[g]
UTAMA	243[d]	1.80[c]	2.51[d]
MESTI-BEST	259[d]	2.03[b]	2.83[c]
HALFOMAR	345[abc]	1.13[f]	1.50[f]
SALAM	–	1.58[de]	2.08[e]
UKM	–	3.04[a]	3.91[a]

[1] Means of 3 samples (wet weight)
Means with different superscripts within each column indicate significant differences ($P < 0.05$)

TABLE 7
Meat and lean meat content of local beef burgers using various methods

Brand names[5]	Meat[1] (%)	Meat[2] (%)	Meat[3] (%)	Lean meat[4] (%)
FIKA	63.2[ab] ± 2.4	71.1[a] ± 1.6	55.5[c] + 3.7	34.9[dc] ± 4.1
ANGUS	55.5[cde] ± 3.0	55.4[ef] ± 2.2	26.7[f] ± 5.9	15.3[gh] ± 6.2
RAMLY	64.4[a] ± 1.4	65.9[b] ± 1.8	71.7[a] ± 1.8	53.9[a] ± 2.0
WISMA BURGER	59.6[bc] ± 0.6	61.5[c] ± 2.3	55.7[c] ± 0.5	39.7[cd] ± 1.6
PRINCE	22.3[g] ± 0.7	23.5[h] ± 2.0	34.2[e] ± 5.1	19.2[f] ± 2.9
BIFFI	34.9[f] ± 6.9	35.7[g] ± 0.2	42.4[d] ± 3.8	31.1[e] ± 2.2
KB	52.3[de] ± 1.9	56.5[de] ± 2.0	55.9[c] ± 4.8	33.8[de] ± 5.2
AMIRUL	34.8[f] ± 3.6	35.0[g] ± 1.1	20.8[ef] ± 0.4	15.9[gh] ± 1.9
UTAMA	56.1[cd] ± 1.8	59.4[cd] ± 2.3	32.7[ef] ± 3.0	12.3[g] ± 4.0
MESTI-BEST	52.8[de] ± 4.1	56.4[de] ± 3.2	48.8[c] ± 7.9	40.4[cd] ± 6.6
HALFOMAR	51.6[e] ± 2.4	52.5[f] ± 2.4	75.9[a] ± 4.0	49.3[ab] ± 1.8
SALAM	59.6[bc] ± 2.8	60.5[c] ± 0.4	64.9[b] ± 1.5	38.7[cd] ± 2.5
UKM*	65.0[a] ± 0.3	65.3[b] ± 1.6	43.3[d] ± 1.5	44.5[bc] ± 2.0

[1]Meat content using myoglobin as indicator
[2] Meat content using total pigments as indicator
[3] Meat content using Stubbs and More method (1919)
[4] Meat content using modified Pearson Method (1975)
[5] Mean n = 3

UKM* - Formulated Beef Burger

Indian Beef that is commonly used in the Burger Industry. It is felt that the determination of meat content in local beef burger can be achieved satisfactorily by formulating Indian beef standards as a reference using myoglobin as an indicator.

The conversion factor using myoglobin as indicator is 4.93, a mean on a fat free basis for

Appendix 1
Coefficient variation and standard deviation of Indian beef samples

	Mean[1] Conc. (mg/g)	SD (mg/g)	CV (%)
Total pigment			
Wet weight	6.23	1.32	21.12
Dry weight	22.72	9.06	39.86
Wet weight Fat free	6.31	1.36	21.60
Dry weight Fat free	27.78	5.09	18.33
Myoglobin			
Wet weight	4.86	1.15	23.78
Dry weight	20.38	4.10	20.11
Wet weight Fat free	4.93	1.17	23.80
Dry weight Fat free	21.66	4.36	20.13

[1]Mean, n = 6

Appendix II
Coefficient variation and standard deviation of 8 selected meat cuts

	Mean[1] Conc. (mg/g)	SD (mg/g)	CV (%)
Total pigment			
Wet weight	4.95	1.00	20.18
Dry weight	19.92	3.85	19.33
Wet weight Fat free	5.27	1.30	24.58
Dry weight Fat free	31.80	25.29	79.52
Myoglobin			
Wet weight	4.03	1.11	27.54
Dry weight	16.59	4.89	29.48
Wet weight Fat free	4.28	1.45	33.88
Dry weight Fat free	26.86	25.16	93.67

[1] Mean, n = 8
[2] Selected Meat Cuts
IB, MDB, MBC, MBT, MBB, MBTC, MBFT, MBFC

Indian beef. This research concludes that this conversion factor is suitable as a reference because other meat cuts with higher pigment contents are uneconomical for use in the burger manufacturing industry.

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(Received 29 October, 1988)