The nutritional value of some processed meat products in Malaysia

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ABSTRACT

Per capita consumption of meat and meat products in Malaysia more than doubled from 15.70 kg in 1970 to 35.71 kg in 1990. This increase in meat consumption is mainly due to the rapid development and wide acceptance of value added meat and poultry products amongst Malaysian consumers. Meat products such as burgers, sausages, hotdogs and nuggets are widely accepted and consumed by all ethnic groups at home as well as in the fast food restaurants. The significant expansion of the fast food industry and the increase consumption of processed meat products makes it necessary for a re-evaluation of the nutritional quality of popular meat products currently available in the market. This review paper described the quality of some processed meat products, their proximate composition, meat quality, use of non meat proteins and binders, and the use of additives in the formulation of burgers, frankfurters, nuggets, bologna, chicken and beef balls. Preliminary results on the protein efficiency ratio of local meat products seemed favourable but this study is limited to only one laboratory. In vivo and in vitro protein digestibility studies indicated high values on the digestibility of locally manufactured meat products. Proximate analysis of the raw materials used in the formulation of such products showed many with high fat and low protein contents being utilized. The meat content was lower than the minimum amount stated by the food regulation. This paper concludes that due to lack of information and studies on the nutritional composition of processed meat products, concerned bodies should take positive steps to generate reliable data to elucidate the actual nutritional composition of such products. It is also observed that many by-products from the animal industry from non-conventional sources are increasingly being utilized in the manufacture of processed meat product.

INTRODUCTION

Malaysia has achieved rapid growth in the food industry sector. Of special interest currently is the significant development of value-added meat products dominating the chill and frozen section of retail outlets, supermarkets and fast food chains of restaurants. In 1983 the value of processed food originating from livestock exceeded 1,600 million Malaysian Ringgit. Malaysia imported about 30,000 tons of red meat in 1985 and estimate for 1995 is about 45,000 tons. Lately, most of the red meat is imported from India. Poultry and pig consumption are also expected to increase to 400,000 tons and 200,000 tons in 1995 respectively. Processed meats, especially hot dogs and hamburgers are common food items to many fast food outlets and supermarkets. In 1989 processed meats amounted to 45 million ringgit. Today, local producers have come out with many processed meats; mainly burgers, hotdogs, nuggets, sausages and meat balls and to a lesser extent, bologna, meat loaf, Salami and cured meat products. The specifications for Malaysian style processed meats are not clear but the Food Regulations (1985) do cover for minimum requirements for meat content, microbiology safety and the use of food additives for preservation purpose in such meat products.

Research and development on value-added meat products are limited to only a few institutions, namely UKM, UPM, IMR and MARDI. A literature search on nutritional information on local meat and meat products revealed some food composition data/information and isolated research papers on the nutritional quality of a few local meat products. With consumption of further processed poultry and meat items on the increase and the meat industry utilizing more raw materials for value added products, it is important for scientists and nutritionists to monitor the quality of such food products. This paper reviews some R&D results pertaining to the chemical composition, food additives, meat content, and nutritional quality of some locally processed meat products.

FOOD COMPONENTS AND CHEMICAL COMPOSITION

The most popular meat product in Malaysia today is the burger (chicken and beef). To date there are about 20 local manufacturers of beef and chicken burgers. Many used imported buffalo meat (from India) as the main component because it is readily available at low cost compared to local beef for making beef burgers. For chicken burger, trimmings and lower priced cuts and spent hens are utilized for the formulation. Many other non-meat components are added in locally produced burgers (Tables 1, 2). These include textured vegetable protein, bread crumbs, starch, ox-fat, soya bean, egg powder, potatoes, groundnuts, gluten and caseinate. Local burgers also include additives, (phosphates, monosodium glutamate, salts, artificial flavors, soy sauce, sugar and nitrate), spices, (chilli, curry, paprika, coriander, garlic, onion, tumeric, ginger and others) colours, (Apo-carotenal, sunset yellow, EdicolOrange and Geranyl 2G) and

Table 1. Local brand names of beefburgers, manufacturers and ingredient

Brand names	*Manufacturers*	*Ingredients**
A - FIKA	Fika Foods Company	Beef, onion, veg. protein, sugar and salt
B - ANGUS	Cold Storage (M) Bhd.	Beef, soya, salt and spices
C - PRINCE	Yeo Hiap Seng (M) Bhd.	Beef, ox fat, bread crumbs, salt and spices
D - HALFOMAR	Halfomar Sdn Bhd.	Meat, veg. protein, salt, starch, spices and flavourings
E - UTAMA	Syarikat Perniagaan Sri Utama	Beef, soybean, egg, bread, salt and spices
F - KB	Kok Wang Brothers	Beef, egg, spices, groundnut, butter, starch, bread, salt
G - AMIRUL	Syarikat Amirul	Beef, fat, starch, bread, salt and spices
H - MESTI BEST	Denmark Sdn bhd	Beef, bread starch, salt and spices
I - WISMA BURGER	Wisma Burger	Meat, flavourings, soya bean, spices, potatoes, egg
J - BIFFI	Yeo Hiap Seng (M) Bhd.	Beef, soya bean protein, onion, corn starch, sodium chloride, polyphosphate, MSG, sugar
K - RAMLY	Perusahaan Burger Ramly Mokni Sdn. Bhd.	Beef, ox fat, soya protein, spices, sugar and salt
L - SALAM	Fika Foods Company	Beef, ox fat, soya protein, spices, sugar and salt

*Ingredients as printed on the packaging material
Source: Babji (1988a).

food preservatives. The proximate analyses of locally processed beef and chicken burgers have beened reported by Babji (1986; 1988a; 1988b), Babji, Sayuwa and Aminah (1985) and Babji and Letchumanan (1989). We observed that in general locally produced burgers have lower protein and higher fat and carbohydrate contents, when compared to those from franchised burger products. Table 3 shows the protein, fat, moisture, ash and carbohydrate contents of local beef and chicken burgers. The lower protein content is due to substitution with non meat components mentioned earlier,since beef and chicken (meat proteins) are relatively more expensive than non-meat components. Fat content did not exceed 30% (maximum amount stipulated in the Food Regulation, 1985) in most locally produced burgers, but it is relatively higher.

Table 2. Food additives formulated into various processed meats in Malaysia

Additives	*Binders/Fillers*	*Spices*	*Colours*	*Preservatives*
Corn flour	Breadcrumbs	Caraway seed	Apo-carotenal	BHA
Dextrose	Na Caseinate	Chilly powder	Beta-carotenal	Glycerol
MSG	Soya Isolate	Curry powder	Brown HT	Propyleneglycol
$NaOH_2$	Soya Concentrate	Pepper	Edicol Orange	Na-sorbate
$NaNO_3$	Soya Flour	Paprika	Geranyl 2G	Na-benzoate
Na Erythrobate	Egg Powder	Sage	Edicol Brown	
Polyphosphates	Starch	Thyme	Geranial Pink	TBHQ
Salt	Butter	Coriander		
Soya sauce	Wheat Flour	Garlic		
Sugar	Corn Flour	Onion		
Wine	Groundnut	Tumeric		
Chicken bouillon	Potatoes	Mustard		
Chicken flavour		Nutmeg		
Bacon flavour		Ginger		
Roast beef flavour		Cloves		

Types of Meats used in Processed Meats:

Beef Trim 30-40VL	Pork
Beef Trim 50-60VL	Ox fat
Beef Trim 70-80VL	Pre-emulsion
Beef Brisket	(chicken fat, casein, hot water)
Buffalo Meat 90VL	Mechanical Deboned Beef
Chicken Meat	
Chicken Fat	

Source: From interviews and personal communication with some local meat manufacturers

Table 3. Proximate analyses of locally processed burgers (wet weight basis)*

Brand names	*Protein (%)*	*Fat (%)*	*Moisture (%)*	*Ash (%)*	*Carbohydrate (%)*
A	12.6±0.4	22.0±0.3	53.0±0.9	2.0±0.0	8.8±3.0
B	10.8±0.8	19.8±0.4	53.6±1.2	2.6±0.0	13.3±2.4
C	15.9±1.4	21.4±1.6	57.2±0.1	1.8±0.0	4.0±1.4
D	14.2±0.1	18.4±0.8	57.6±0.1	2.0±0.2	7.9±1.1
E	13.8±0.3	15.4±2.5	59.6±0.1	2.2±0.0	9.0±2.7
F	15.1±0.1	14.9±3.8	63.5±1.4	2.3±0.0	4.6±4.6
G	13.4±1.2	23.3±0.3	48.3±1.5	2.4±0.0	12.7±2.2
H	12.1±0.1	15.0±1.0	64.7±0.2	1.9±0.0	6.3±1.0
I	12.7±0.3	19.6±0.7	41.9±0.4	2.4±0.0	23.5±0.1
K	14.3±0.1	28.7±2.4	52.4±1.6	2.3±0.1	2.4±4.0
L	14.4±0.8	27.5±11.2	53.5±0.3	2.3±0.0	0.7±0.6

* Mean values derived from 3 sample per treatment Source: Babji (1988a)

A - L are brand names as listed in order in Table 1

than those of the franchised produced burgers.

Table 4 shows the quantification of meat content, soy protein concentrate, and cereal starch component in local beef burgers. Total pigment was taken as the best estimate for meat content (Babji 1988). Total pigment ranged from a low of 0.51 mg/g to a high of 3.10 mg/g of meat, corresponding to 23.5 to 70.1% meat content respectively. All, except for two brand names of beef burgers contained less than 65% meat (minimum requirement stipulated by Food Regulation 1985). Soy protein ranged from 15.4 to 36.5%. Beef burgers with lower meat content seem to have more soya protein and cereal added in the formulation. In an earlier study, Babji et al. (1985) compared three franchised beef burgers with seven popular locally manufactured beef burgers. Table 5 shows that using total pigment as an indicator to measure meat content, the 100% meat content of franchised burger is equivalent to about 4.8 - 5 mg/g meat. Soy protein concentrate, soya flour and cereals are used to substitute meat in the locally produced beef burgers.

The addition of other components such as non-meat protein, water and food additive are shown in Table 6. The Food Regulation (1985) stated that processed meat should not contain less than 1.7% nitrogen in the organic form. In our study (1988) the total nitrogen content ranged from 1.84 to 2.56%, thus satisfying the nitrogen requirement. It should be noted that non-meat components such as

Table 4. Total pigments, soy protein, cereal and meat contents of hamburgers

Brand names	*Total pigments*[1] *mg/g*	*soy protein*[2] *% conc*	*Cereal*[3] *%*	*Meat content*[4] *%*
A	3.10	17.5 ± 0.9	2.8	71.1 ± 1.6
B	2.25	32.5 ± 2.4	1.7	55.4 ± 2.2
C	2.81	17.0 ± 0.5	2.0	65.9 ± 1.8
D	2.72	21.0 ± 2.0	1.3	61.5 ± 2.3
E	0.51	36.5 ± 0.5	2.8	23.5 ± 2.0
F	1.53	33.0 ± 1.8	5.1	35.7 ± 0.2
0	2.10	19.5 ± 2.2	1.8	56.5 ± 2.0
H	1.26	34.5±1.6	1.1	35.0±1.1
I	2.51	29.5 ± 2.4	3.1	59.4 ± 2.3
J	2.83	18.5 ± 0.8	27.4	56.4 ± 3.2
K	1.50	15.5 ± 1.7	0.9	52.5 ± 2.4
L	2.08	26.0 ± 1.5	4.2	60.5 ± 0.4

1-n = 3. based on wet weight (Rickansrud & Henrickson, 1967)
2-n = 3. based on Enzymatic technique (Morissey et a], 1982)
3-n = 3. based on configuration method (AOAC, 1980)
4-n = 3. based on total pigments as an indicator of meat content.
Source: Babji (1988a)
A - L are brand names as listed in order in Table 1

Table 5. Mean values of soy protein, cereal, total meat pigment and estimated meat contents in local and franchised beef burgers in Malaysia*

Brand names	*Soy Protein Conc. (%)*	*Soya Flour (%)*	*Cereal (%)*	*Total Pigment (%)*	*Estimated Meat (%)*
Local					
Prince	10.9	19.0	9.9	2.1	42
Angus	5.5	13.2	10.4	1.6	32
KB	4.9	11.8	23.8	2.5	50
Fika	2.9	7.0	8.7	3.3	66
Halfomar	2.5	6.0	15.3	2.7	54
Ko-Op	2.4	5.8	19.7	0.9	18
Thrifty	1.3	3.1	29.3	1.6	32
Franchised					
A & W	0.0	0.0	0.0	5.0	100
McDonald's	0.0	0.0	0.0	4.9	100
Wendy	0.0	0.0	0.0	4.8	100

*Mean values from 4 samples/treatment
Source: Babji *et al.* (1985)

Table 6. Total nitrogen content, phosphorus pentoxide, added water and Feder number in locally processed hamburgers.*

Brand names	*Total nitrogen (%)*	*P O (%)*	*Added water (%)*	*Feder No. (%)*
A	2.08	0.26	15.7	2.31
B	1.84	0.29	34.8	2.24
C	2.56	0.19	7.6	2.93
D	2.34	0.18	16.5	2.62
E	2.34	0.21	23.9	2.63
F	2.54	0.21	23.0	3.01
0	2.21	0.16	11.7	1.86
H	2.06	0.20	25.0	3.53
I	2.14	0.19	15.7	1.15
J	2.39	0.16	18.8	1.94
K	2.35	0.20	8.8	3.29
L	2.41	-----	17.8	3.73

* Mean, n = 3, based wet weight
Source : Babji (1988a)
A ---- L are brand names as listed in order in Table 1.

soyprotein, cereals and other protein components are also formulated into locally manufactured hamburgers. For beef burger, beef trimming, chuck or buffalo meat are used with TVP, starch, spice mix, sugar, MSG, onion and pepper. Some used egg white, colours, and special spice mix to obtain products with flavour, colour texture and taste to the liking of Malaysian taste buds. In the last few years, manufacturers have been looking seriously into maximizing the utilization of animal industry by products. With export market demanding more premium cuts and portion of poultry meat, a new range of unconventional byproducts are now available in abundance for utilization in value added meat products. These include mechanically deboned chicken meat (MDCM), low quality chicken trimmings (LQCT), high quality chicken trimmings (HQCT), bird breader cull (BBC) and breast chicken trimmings (BCT), tons of each being produced from five of the largest poultry industry in Malaysia. Tables 7 & 8 show the proximate composition of conventional and unconventional protein raw materials currently available from the poultry industry. Tables 9 shows the composition of protein, fat, ash and moisture of various type of chicken meat products that are locally manufactured. Many of these products utilized the newly-found unconventional by-products as shown in Table 8.

BIOLOGICAL EVALUATION OF MEAT PROTEINS

Babji and Letchumanan (1989) reported on the rat bioassay for protein efficiency ratio, in-vitro protein digestibility as well as in vivo digestibility of protein in locally produced beef burgers and compared the results with pure beef burgers as well as soy-beef burger. Table 10 shows the PER values, in-vitro and in-vivo protein digestibilities of locally produced beef burgers with comparison to pure beef, soya beef and a casein reference. Although the PER values were lower than pure beef and soya-beef, local beef burgers had

Table 7. Proximate analyses of raw material (Conventional and non-conventional proteins) from poultry industry*

Raw Material	*Fat (96)*	*Moisture (96)*	*Protein (96)*	*Ash (96)*
Fillet B	0.13 ± 0.05	73.95 ± 0.08	26.21 ± 0.24	1.21 ± 0.01
Fillet B. B.	0.22 ± 0.06	74.06 ± 0.04	23.46 ± 0.35	1.34 ± 0.02
SBL. B.	15.46± 2.06	73.26± 0.17	13.64± 0.37	0.91 ± 0.02
SBBr.B. (Trimming)	1.39 ± 0.85	72.97 ± 0.04	27.17 ± 0.32	1.06 ± 0.03
Breast skin	50.60 ± 0.03	43.04 ± 0.33	5.69 ± 0.14	0.18 ± 0.01
Leg skin	63.25 ± 0.89	44.12 ± 3.66	9.45 ± 0.24	0.31 ± 0.01
Neck skin	45.42 ± 1.00	51.84 ± 0.01	6.43 ± 0.18	0.23 ± 0.02
Neck	5.37 ± 0.15	72.47 ± 0.78	12.34 ± 0.30	0.57 ± 0.01
Adipos fat	77.79±2.13	19.92±0.01	0.50±0.08	—

SBL.B. — Skinless Boneless Leg, gred B
SBBr.B. — Skinless Boneless Breast, gred B
* Means value from 3 samples

Table 8. Proximate analyses of raw material (Non-conventional protein) from a poultry industry grading system.*

Raw Material	*Protein (%)*	*Fat (%)*	*Moisture (%)*	*Ash (%)*
LQCT	12.58 ± 0.25	18.68 ± 0.93	63.96 ± 0.56	0.56 ± 0.01
HQCT	12.35 ± 0.35	6.81 ± 0.67	28.07 ± 0.45	0.86 ± 0.02
BCT	12.85± 0.27	19.68± 0.82	63.77± 1.15	0.78± 0.02
BBC	15.25 ± 0.36	12.00 ± 0.84	76.90 ± 0.70	0.88 ± 0.02
BBCL	13.46± 0.10	8.29± 0.86	69.59± 0.72	0.91 ± 0.04
TB	16.51 ± 0.03	6.89± 0.53	72.53± 0.60	1.07± 0.01
MDMN	8.42± 0.15	29.73± 1.00	63.06± 1.81	1.42± 0.04
MDMC	11.58 ± 0.26	25.47 ± 0.28	57.74 ± 0.40	1.58 ± 0.06

* Mean values from 3 samples

Indicator:

LQCT - Low Quality Chicken Traimming
HQCT - High Quality Chicken Trimming
BCT - Burger Chicken Trimming
BBC - Bird Breeder Cull
BBCL - Bird Breeder Cull (Leg)
TB - Trimming Breast
MDMN - Mechanical Deboned Meat (Normal)
MDMC - Mechanical Deboned Meat (Cull)

PER value above 2.0, considered good in term of protein quality. Recently, Babji and Ismail (1993) did a preliminary study to evaluate the protein quality of imported hotdog and compared it with two locally produced hotdogs, all made using unconventional protein by products raw materials. The PER values of the two local hotdogs were higher (2.79 and 2.02) compared to the Imported hotdog from a European country which had a PER score of 1.9. The in-vivo protein digestibility was also higher for local hotdog in comparison to the imported hotdog (Table 11). Further studies on the most popular range of local and imported processed meat products is seriously needed. Mechanically deboned poultry meat (MDPM) has recently entered the Malaysian food market. Many imported frankfurters from beef and chicken contained mechanically deboned meat (MDM). The chemical composition and nutritional quality of MDM is different compared to normal meat. Table 12 shows the chemical composition of various type of chicken parts. Generally, the protein content is lower than broiler meat and the fat content is higher (12.0 - 28%). The ash content is also higher ranging from 0.6 - 1.4%. The PER, in-vivo and in-vitro digestibilities of MDPM using rat bioassay are shown in Tables 13 & 14. Babji, Froning and Satterlee (1980) reported PER values of 1.90 - 2.65 indicating good to excellent protein biological value deriving from mechanically deboned processing of meat. Digestibility values are also comparable to standard casein. These results suggested that MDM are beneficial in increasing the nutritional content of such processed poultry products. It has high contents of calcium, phosphorus, iron and other minerals, but also higher content of fat. So nutritionists need to be well informed of the chemical composition and the nutrient contribution from such processed meat products.

Table 9. Proximate analyses in some poultry processed products.*

Raw Material		Fat (%)	Ash (%)	Protein (%)	Moisture (%)
DPP	b	15.34 ± 1.33	1.97 ± 0.08	13.01 ± 1.53	63.78 ± 0.15
DPP	sf	17.62 ± 0.06	2.70 ± 0.07	8.84 ± 0.29	59.45 ± 0.77
DPP	cbp	12.20 ± 0.28	1.46 ± 0.75	11.88 ± 0.67	64.50 ± 1.74
DPP	cbr	9.31 ± 0.21	2.18 ± 0.01	14.61 ± 1.78	64.30 ± 0.01
DPP	cs	2.49 ± 0.25	3.11 ± 0.07	15.90 ± 0.00	74.02 ± 0.22
CS	nug	5.74 ± 1.59	2.22 ± 0.01	7.80 ± 0.49	62.02 ± 0.70
AY	b	11.98 ± 0.54	1.18 ± 0.66	11.80 ± 0.41	67.22 ± 0.51
AY	f	34.94 ± 0.60	3.26 ± 0.01	13.79 ± 0.78	61.61 ± 0.00
AY	cbp	9.87 ± 0.04	2.53 ± 0.00	10.04 ± 0.06	64.94 ± 0.04
AY	cbr	10.96 ± 0.37	3.03 ± 0.02	7.62 ± 0.51	61.22 ± 0.02
AY	cbv	21.59 ± 5.77	2.56 ± 0.02	10.12 ± 0.02	64.67 ± 0.25
AY	nug	33.23 ± 1.07	1.71 ± 0.02	10.23 ± 0.09	52.58 ± 0.74
AY	bol	17.43 ± 0.29	1.57 ± 0.59	12.05 ± 0.08	60.56 ± 0.07
Al	f	17.55 ± 0.72	2.20 ± 0.03	8.48 ± 0.12	63.60 ± 0.03
Al	cb	6.84 ± 0.96	1.86 ± 0.00	10.74 ± 0.06	71.36 ± 0.01
Bif	bf	11.09 ± 0.17	2.76 ± 0.06	10.75 ± 0.00	66.51 ± 0.12
Ram	bb	14.30 ± 0.21	2.27 ± 0.04	17.11 ± 0.07	55.50 ± 0.02

* Mean values from 3 samples

DPP b – DPP chicken burger
DPP sf – DPP smoked franks
DPP cbp – DPP chicken ball plain
DPP cbr – DPP chicken ball rendang
DPP cs – DPP chicken sandwich
CS nug – Cold Storage nugget
AY b – Ayamas burger
AY f – Ayamas franks
AY cbp – Ayamas chicken ball plain
AY cbv – Ayamas chicken ball vegetable
AY cbr – Ayamas chicken ball rendang
AY nug – Ayamas nugget
AY bol – Ayamas bologna
AY f – Ayam al frankfurter
Al cb – Ayam Al chicken ball
Bif bf – Biffi beef frank
Ram bb – Ramli beef burger

Table 10. PER values, % in vivo apparent disgestibility and in vitro digestibility of local, formulated hamburgers and casein reference.[2]

Source of protein	PER [1, 3] x ± S.D.	Adj. PER	% Apparent Digestibility [1,3] ± S.D.	% In Vitro Digestibility
Pure	2.98 ± 0.23ab	3.24	90.04 ± 0.62a	85.57 ± 3.58
Mixture (70, 30)	2.94 ± 0.25ab	3.20	87.91 ± 1.66b	84.82 ± 4.26
Angus	2.26 ± 0.42d	2.46	85.50 ± 1.26c	82.94 ± 4.15
Fika	2.38 ± 0.33cd	2.59	86.18 ± 1.41bc	83.31 ± 5.55
Ramly	2.45 ± 0.27cd	2.66	85.50 ± 1.96c	82.56 ± 4.22
Thrifty	2.67 ± 0.30abc	2.90	85.91 ± 0.81bc	83.69 ± 4.61
Casein	2.30 ± 0.26d	–	90.58 ± 1.80a	87.45 ± 2.96

1 Mean and standard deviation from 8 rats.
2 Mean of two samples.
3 Means with different alphabet are significantly different ($P < 0.05$).
4 Means and standard deviation of three samples.
Source: Babji & Letchumanan (1989).

.**Table 11.** PER values and in vivo protein digestibility of chicken frankfurter samples.

Protein source *	*PER values*	*In vivo protein digestibility*
Casein	1.15	93.91± 2.01
AyamAl	2.79	84.39± 7.45
DPP	2.02	81.02± 1.90
Doux	1.90	78.05 ± 8.63

*Samples of different brand of chicken frankfurthers.

Table 12. Composition of mechanically deboned poultry meat (MDPM)

Meat Type	*Protein (%)*	*Moisture (%)*	*Fat (%)*	*Ash (%)*
MDCM	9 – 14	60 – 70	12 – 28	0.6 – 1.4
Chicken back & neck[a]	14.5	66.6	17.2	–
Chicken back & neck[b]	9.3	63.4	27.2	–
Spent layers[b]	14.2	60.1	26.2	–
Spent layers [c]	13.9	65.1	18.3	–
Turkey frame meat[d]	12.8	70.7	14.4	–
Turkey frame meat[b]	12.8	73.7	12.7	–

[a] Froning, G. W. (1970).
[b] Grunden, et. al. (1972).
[c] Froning , G. W. and Johnson, E. (1973).
[d] Froning *et. al.* (1971).

Table 13. In vivo and in vitro measurements of protein digestibility of mechanically deboned poultry meat.

Sample	*In vivo digestibility*[a]	*In vitro digestibility*[b]
Casein (ANRC)[c]	91.20	90.00[d]
MDCM	89.92	89.33[e]
CMDCM	90.11	90.00[e]
MDTM	87.04	88.65[e]

[a] Poooled mean from 10 rats per treatment.
[b] Adjusted in vitro digestibility = 234.84 – 22.56 (x). (x = adjusted pH drop at 20 minutes).
[c] ANRC – Animal Nutrition Research Council.
[d] Average of 5 runs; this casein was used to teat the multienzyme activity before each run.
[e] Average of duplicate runs.
Source: Babji *et. al.* (1980).

Table 14. Protein efficiency ratios for rats fed mechanically deboned poultry meat.

Diet	*PER uncorrected*	*PER corrected*
Casein (ANRC)[ab]	3.22	2.50
MDCM	3.01	2.34
CMDCM	3.11	2.41
MDTM	3.34	2.59
Casein (8% fat)[C]	—	2.36
Broiler SN[C]	—	2.65
Broiler SNBK[C]	—	2.47
Broiler BK[C]	—	1.90

a Animal Nutrition Research Council.
b Average of 10 weaning rats/treatment.
c Data from MacNeil *et. al.* (1978).
Source: Babji *et. al.* (1980).

CONCLUSION

Nutritional information such as proximate composition and biological values (PER, in vitro and in vivo digestibility) are seriously lacking on meat products like burgers, hotdogs and other processed meat products in Malaysia. The data presented in this paper is limited to one laboratory. There is a need to conduct more studies on the chemical composition and nutritional evaluation of locally processed meat products. The few studies carried out earlier indicated the use of non-meat proteins in many local products, some of which have lower protein content and biological value when compared to pure meat samples.

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