ASSESSMENT OF BIOLOGICAL VALUE OF SEVEN EGYPTIAN BUFFALO MEAT BY-PRODUCTS

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SUMMARY

This investigation was performed in an attempt to assess the biological value of seven buffalo meat by-products, namely: liver, heart, kidney, brain, spleen, tongue, and lung.

Representative samples from these organs were withdrawn immediately after slaughtering from Assiut abattoir, from buffaloes with an average age of 2 years.

The results led to the following conclusions:

1 - Amino nitrogen content was higher in buffalo spleen than that in other studied meat organs. Meanwhile, water insoluble nitrogen content was higher in buffalo heart than that in other studied six meat organs.

2 - Buffalo liver and tongue proved to have more non-protein nitrogen content than that in other studied meat organs. However, the latter were higher in protein nitrogen.

3 - All buffalo meat organs proteins are deficient in the limiting amino acid methionine.

4 - Generally it can be calculated that the biological value of liver protein of buffalo may be considered the highest, followed by that of spleen, lung, heart, kidney, and tongue. However, brain proved to have the lowest biological value among all the seven studied organs.

INTRODUCTION

There remain to be dealt with parts of animals, other than the flesh, which are sometimes used as food, and usually classed together as offal. These comprise such articles as the kidneys, liver, blood, heart, lungs, and other internal organs, and together they make up about one-third of the total weight of the carcass. The importance of some of these in diet cannot be overrated.

From the chemical point of view, they are substances of considerable nutritive value as important sources of protein. Moreover, they have remarkable properties in supplying protective factors, such as vitamins, iron, etc. Liver has massive quantities of vitamin A and B complex and available iron, the rest are very useful for thiamine.

The physical properties of liver and kidneys renders them somewhat difficult of digestion, unless they have been minced before cooking. Chemically, both consist chiefly of protein along with a small amount of fat.

Because of a denser structure of heart, it is less digestible. For healthy persons, however, it is an excellent and economical food.

The brain of animals is only occasionally eaten as food. Brain contains a small amount of protein and some fatty material including cholesterol and phospholipids. (Hugh and Dorothy 1969).

The potential of internal organs and meat by-products as a source of high-value animal protein is considered, with values for essential amino acid concentration (Gorbatov 1976).

Osborne and Voogt (1978) reported that the average protein content in flesh or organs was as follows: Kidney 17% and Liver 19%.

Oliveros et al. (1982), reported that all meat by-products (beef, tongue, heart, lungs, spleen, liver, and kidneys) had significantly lower protein content than beef lean which

Table 1: Protein fraction of fresh organs of buffalo*.

Variety meats	T.N.	AN (mg/100 g)	WISN (g/100 g)	WSN (g/100 g)	NPN (g/100 g)	PN (g/100 g)
Liver	11.13^{c}	0.84^{b}	50.01^{d}	49.98^{d}	14.39^{a}	85.60^{d}
Heart	12.73^{b}	0.38^{f}	83.35^{a}	16.64^{g}	8.33^{bc}	91.66^{bc}
Kidney	12.85^{a}	0.47^{e}	43.00^{e}	56.10^{c}	9.75^{b}	90.24^{c}
Brain	8.88^{c}	0.53^{d}	18.18^{g}	81.81^{a}	7.27^{cd}	92.73^{ab}
Tongue	8.27^{e}	0.21^{g}	59.01^{b}	40.97^{f}	13.99^{a}	86.00^{d}
Spleen	12.87^{a}	1.21^{a}	55.36^{c}	44.62^{e}	5.54^{d}	94.46^{a}
Lung	12.73^{b}	0.59^{c}	22.65^{f}	77.33^{b}	6.04^{d}	93.95^{a}

* Calculated on dry weight basis.
TN = Total nitrogen content
AN = Amino nitrogen content
WISN = Water insoluble nitrogen content
WSN = Water soluble nitrogen content
NPN = Non protein nitrogen content
PN = Protein nitrogen content
(a,b,c,d,e,f,g)= Symbols indicating the result of dunken test.

Table 2: Indispensable amino acids of whole egg and organ proteins.

Indispensable amino acid (I.A.A.)	Whole Egg* Ae	$\frac{Ae}{Ee}$	Buffalo Liver Ax	$\frac{Ax}{Ex}$	$\frac{A}{E}$	$\frac{A}{T}$
Iso-leucine	415	148	196	92	116	88
Leucine	553	197	716	336		
Lysine	403	144	433	203	140	107
Methionine	197	70	96	45	64	48
Phenylalanine	365	130	201	94	72	55
Threonine	317	113	173	81	71	54
Tryptophan	100	36	68	31	86	68
Valine	454	162	245	115	70	53
Total I.A.A.	2804		2128			
Chemical score		100			64	48

* F.A.O.: Nutrition meeting reports series No. 37 (78).

Table 3: Indispensable amino acids of whole egg and organ proteins.

Indispensable amino acid (I.A.A.)	Whole Egg* Ae	Ae/Ee	Buffalo Heart Ax	Ax/Ex	A/E	A/T
Iso-leucine	415	148	206	98	114	85
Leucine	553	197	672	322		
Lysine	403	144	513	246	170	127
Methionine	197	70	78	37	52	39
Phenylalanine	365	130	183	87	66	50
Threonine	317	113	161	77	68	50
Tryptophan	100	36	54	25	69	54
Valine	454	162	216	103	63	47
Total I.A.A.	2804		2083			
Chemical score		100			52	39

Table 4: Indispensable amino acids of whole egg and organ proteins.

Indispensable Amino acid (I.A.A.)	Whole Egg* Ae	Ae/Ee	Buffalo Kidney Ax	Ax/Ex	A/E	A/T
Iso-leucine	415	148	188	91	115	84
Leucine	553	197	684	334		
Lysine	403	144	484	236	163	120
Methionine	197	70	80	39	55	40
Phenylalanine	365	130	195	95	73	53
Threonine	317	113	155	75	66	48
Tryptophan	100	36	64	31	86	64
Valine	454	162	197	96	59	43
Total I.A.A.	2804		2047			
Chemical score		100			55	40

Table 5: Indispensable amino acids of whole egg and organ proteins

Indispensable amino acid (I.A.A.)	Whole Egg* Ae	Ae/Ee	Buffalo Brain Ax	Ax/Ex	A/E	A/T
Iso-leucine	415	148	181	80	110	88
Leucine	553	197	739	329		
Lysine	403	144	581	258	179	144
Methionine	197	70	75	33	47	38
Phenylalanine	365	130	226	100	76	61
Threonine	317	113	168	74	65	52
Tryptophan	100	36	83	36	100	83
Valine	454	162	193	85	52	42
Total I.A.A.	2804		2246			
Chemical score		100			47	38

are used as standard. Spleen and liver contained significantly more protein than the other by-products studied.

Stade (1985), studied the nutritional value of edible offals such as, liver, kidneys, heart, tongue, and brain.

Up to the authors' knowledge there is no available data on the biological value of Egyptian buffalo meat by-products. Therefore, this investigation was performed in an attempt to assess the biological value of seven buffalo meat by-products.

MATERIALS AND METHODS

a. Materials:

Representative samples from each of the specified buffalo organs, namely: liver, heart, kidney, brain, spleen, tongue, and lung, were obtained immediately after slaughtering from Assiut abattoir, from buffaloes with an average age of 2 years.

b. Methods:

The moisture content, total nitrogen content, water insoluble nitrogen and free amino nitrogen were determined in fresh organs according to the method described in A.O.A.C. (1980). Protein nitrogen contents and water soluble nitrogen were calculated, by difference. Non-protein nitrogen content was determined according to the method given by Hughes (1961).

The amino acids were determined using paper chromatographic technique according to Block et al. (1958) and Youssef (1962).

Tryptophan content was determined colorimetrically using the method described by Spices and Dorris (1948).

Chemical score for the evaluation of the biological value of buffalo meat by-products were calculated to A/E and A/T F.A.O. methods (1974).

RESULTS AND DISCUSSION

a. Protein fractions of fresh buffalo organs:

Results in Table (1) indicate that total nitrogen and amino nitrogen contents were higher in buffalo spleen than in other studied organs. Meanwhile, water insoluble nitrogen content was higher in buffalo heart than that in other studied six meat organs. Buffalo liver and tongue proved to have more non protein nitrogen content than that in other studied meat organs. However, the latter were higher in protein nitrogen.

Stekol'nikov et al. (1982) found that the crude protein in both of pancreas after insulin preparation and lungs after preparation of heparin respectively were 68.72% and 82.5%.

Through succinylation of protein during alkaline extraction, solubility of protein in distilled water, water hydration and whippability of the isolates were increased (Song et al. 1984).

Smith and Brekke (1984) reported that modification of heart myofibrils with ficin was effective in improving protein solubility. Such findings might clarify the relative variations in nitrogen fractions of buffalo meat by-products in the present study.

Ibarra et al. (1985) studied various physical and chemical characteristics of pork lean and by-products. All the by-products except the liver had significantly lower crude protein than pork lean. Liver and kidney had no observable expressible water, tongue had very high expressible water levels. Stability of emulsions made of spleen, kidney and liver was very high.

Table 6: Indispensable amino acids of whole egg and organ proteins.

Indispensable amino acid (I.A.A.)	Whole Egg* Ae	Ae/Ee	Buffalo Tongue Ax	Ax/Ex	A/E	A/T
Iso-leucine	415	148	203	88	108	88
Leucine	553	197	709	310		
Lysine	403	144	640	280	194	158
Methionine	197	70	70	30	42	35
Phenylalanine	365	130	211	92	70	57
Threonine	317	113	165	72	63	52
Tryptophan	100	36	82	35	97	82
Valine	454	162	201	88	54	44
Total I.A.A	2804		2281			
Chemical score		100			42	35

Table 7: Indispensable amino acids of whole egg and organ proteins.

Indispensable amino acid (I.A.A.)	Whole Egg* Ae	Ae/Ee	Buffalo Spleen Ax	Ax/Ex	A/E	A/T
Iso-leucine	415	148	170	86	112	78
Leucine	553	197	646	328		
Lysine	403	144	410	208	144	101
Methionine	197	70	83	42	60	42
Phenylalanine	365	130	200	101	77	54
Threonine	317	113	172	87	76	54
Tryptophan	100	36	67	34	94	67
Valine	454	162	220	111	68	48
Total I.A.A.	2804		1968			
Chemical score		100			60	42

Table 8: Indispensable amino acids of whole egg and organ proteins.

Indispensable amino acid (I.A.A.)	Whole Egg* Ae	Ae/Ee	Buffalo Lung Ax	Ax/Ex	A/E	A/T
Iso-leucine	415	148	165	78	114	85
Leucine	553	197	732	349		
Lysine	403	144	513	244	169	127
Methionine	197	70	74	35	50	37
Phenylalanine	365	130	211	100	76	57
Threonine	317	113	137	65	57	43
Tryptophan	100	36	61	29	80	61
Valine	454	162	204	97	59	44
Total I.A.A.	2804		2097			
Chemical score		100			50	37

b. Amino acid content and biological value assessment of fresh buffalo organs:

Tables (2-8) show a comparison between the essential amino acids content (EAA) of whole egg and buffalo organs protein as well as the calculated chemical scores of the organs proteins by the two methods suggested by the F.A.O. (1974). It is clear that the organs proteins are deficient in the amino acid methionine as obvious from the chemical scores being calculated from A/E and A/T ratios.

To meet the requirement of man (2.2) grams of the essential amino acid methionine (Rose et al. 1955) assuming that organ is the only protein source in the human diet, one needs to calculate the grams of organs covering the daily requirement of the amino acid methionine, since such amino acid is the limiting amino acid of the organs protein.

The grams of organs covering the daily requirement of amino acid methionine was as follows: liver 732, heart 1117, kidney 1137, brain 1521, tongue 1175, spleen 1037, and lung 1088 grams.

From the above mentioned discussion it can be concluded that the brain is generally lower in its biological value than other studied organs.

However, Poin (1970) found that there were only slight differences between the essential amino acids contents (expressed in g/16 g N) of high protein and low protein meat meal.

It is noteworthy that all by-products tissues were low in methionine, when compared to whole egg protein (Satterlee and Free 1973).

Farstad (1977), found that the nutritional value of spleen is slightly inferior to that of liver.

Song et al. (1984) reported that the amino acid composition of liver protein isolates was excellent, except valine and isoleucine, but other protein isolates generally had lower amino acid contents than FAO/WHO recommended chemical score. S-containing amino acids were limiting.

Gelencher et al. (1985) offal found that protein efficiency ratio (PER) value were significantly lower, and were lower in pigs than in cattle. The main conclusions were that presence of connective tissue lowers the nutritive value of proteins.

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