SPECIES DIFFERENCES IN PROTEINS OF ABATTOIR OFFAL

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INTRODUCTION

There is continuing interest in the possibility of upgrading the protein of currently wasted or underutilized abattoir offal into a form which would be suitable for human consumption.

Differences between the various offal tissues in such features as protein extractability, and in the ability to form fibres or other meat simulations have been demonstrated (Young & Lawrie, 1974, 1975a,b : Swingler & Lawrie, 1978); but, hitherto, relatively little attention has been given to the possible effect of species.

Indications that blood plasma from the pig behaves differently to that of cattle in such parameters as gel strength and viscosity, when used as textural adjuncts in food commodities, made it desirable to compare the behaviour of proteins derived from other abattoir offal from cattle, sheep and pigs. Some relevant findings from recent investigations (Gault & Lawrie, 1980) are reported in this communication.

MATERIALS AND METHODS

Lungs, rumen, stomach and large and small intestines from cattle, sheep and pigs were obtained from newly slaughtered animals. After washing and trimming, tissues were minced and stored in polythene bags at 4°C for not more than 24 hr.

Total protein (N x 6.25) was determined by microkjeldahl procedure on 2g. samples of raw mince, or5 ml aliquots of extract supernatants. Collagen was determined (as hydroxyproline) by Woessner's method (1961); and elastin according to Lowry et al. (1941).

Nitrogen solubility was determined in aqueous solution at pH 10.5 and in 0.01 M sodium dodecyl sulphate (SDS) following the procedure of Young & Lawrie (1974).

SDS-polyacrylamide gel electrophoresis was carried out on freeze-dried protein samples : Approx 10 mg. dried protein were suspended in 1 ml electrophoretic buffer, containing 2% SDS and 2% β-mercaptoethanol. Sucrose (10% v/v) was added to all samples which were then incubated 24 hr. at 80°C to dissolve the proteins. The electrophoretic technique described by Young & Lawrie (1974) was followed. Molecular weights were estimated by referring to the mobility of standard proteins in the system.

Available lysine was determined by the method of Kakade & Liener (1969),

RESULTS AND DISCUSSION

It will be seen from Table 1 that, whereas the percentages of total protein and of collagen in rumen/stomach and large intestine are not dissimilar whether derived from cattle, sheep or pigs, the percentage of protein is rather higher in porcine small intestine than in those of the other two species. Moreover, porcine lung has a distinctly lower content of total protein, and of collagen and elastin specifically, than bovine or ovine. This feature may also explain the greater extractability of protein from porcine lung, by both alkali and SDS (Table 2).

In respect of the proteins solubilized from lung or rumen/stomach by alkali (10.5), the pattern of MW components reveals a number of more subtle differences between the species (Table 3). For example, whereas a molecule of 86000 D is a major feature of bovine lung, it is a minor constituent in porcine lung; and is apparently absent from ovine lung.

Since, of the essential amino acids, lysine is a member which not infrequently tends to be limiting, and, moreover, also tends to link with (10 groups during food processing, its availability is an important criterion of the nutritional status of proteins. Although the proteins of the four tissues of the three species appeared to suffer some loss of lysine availability on extraction - especially by alkali - no consistent pattern, favouring bovine, ovine or porcine tissues in this respect emerged (Table 4).

CONCLUSION

That the proteins of a given offal tissue arenot identical between cattle, sheep and pigs must be presumed to affect their functional properties. Whether or not such differences favour one source or another, however, will depend on the intention. Thus, whereas the greater solubility of porcine lung - and its lower collagen content - might suggest it was superior to that of cattle or sheep, there is some suggestion that it disintegrates on heating to a greater - and less desirable - extent. It is evident that careful attention must be given in the future to species, as well as to tissue, in assessing the usefulness of abattoir offal.

Table 1. Protein and Connective Tissue Content of Offal

(% wet weight basis)

Species	Tissue	% Protein (Mean of S.D.)	% Collagen (Mean of duplicate)	% Elastin (Mean of duplicate)
Bovine	Lung	17.9 ± 1.2 (2)*	2.3	2.5
	Rumen	14.3 ± 1.1 (10)	2.7	-
	Small Intestine	11.8 ± 0.6 (10)	2.7	-
	Large Intestine	12.3 ± 0.6 (6)	2.8	-
Ovine	Lung	17.4 ± 1.3 (10)	2.4	2.4
	Stomach	14.8 ± 0.5 (8)	2.7	-
	Small Intestine	12.7 ± 0.2 (8)	2.7	-
	Large Intestine	12.6 ± 0.3 (4)	2.8	-
Porcine	Lung	15.1 ± 0.5 (8)	1.5	1.7
	Stomach	14.2 ± 0.6 (8)	2.8	-
	Small Intestine	12.6 ± 0.9 (4)	2.9	-
	Large Intestine	13.7 ± 0.2 (4)	3.0	-

* No. of determinations

Table 2. Efficiency of Nitrogen Recovery from Extracts of Offal

(Nm extract of total nitrogen in original tissues)

N in extract as %

Species	Tissue	(a) Alkaline extraction (pH 10.5)	(b) Extraction with sodium dodeyl sulphate (0.01M)
Bovine	Lung	55	69
	Rumen	60	68
	Small Intestine	72	82
	Large Intestine	58	70
Ovine	Lung	58	68
	Stomach	54	71
	Small Intestine	81	85
	Large Intestine	-	-
Porcine	Lung	71	81
	Stomach	74	78
	Small Intestine	67	80
	Large Intestine	-	-

Table 3. Molecular weights of protein sub-units extracted at pH 10.5 from meat waste tissues as estimated by S.D.S. - polyacrylamide gel electrophoresis. (Major components underlined)

Component No. (Order from original)	Bovine Lung	Ovine Lung	Porcine Lung	Bovine Rumen	Ovine Stomach	Porcine Stomach
1	132,000	136,000	132,000	127,000	130,000	126,000
2	86,000	124,000	88,000	117,000	112,000	111,000
3	79,000	120,000	76,000	107,000	105,000	74,000
4	61,000	79,500	63,000	90,000	92,000	67,000
5	51,000	64,000	58,000	78,000	81,000	62,000
6	41,000	58,000	48,000	47,500	65,000	54,000
7	39,500	48,500	39,000	44,000	62,000	49,000
8	36,000	46,000	34,000	41,000	50,000	33,000
9	32,300	44,000	30,000	34,000	46,000	20,500
10	28,500	40,000	28,500	20,500	42,000	18,000
11	23,000	36,000	25,500	18,000	37,000	
12	20,000	32,000	19,500		18,500	
13	16,500	28,500	17,000		17,500	
14	16,000	25,500	15,000		15,500	
15		22,000				
16		19,500				
17		17,000				
18		16,000				

Table 4. Lysine Availability of Freeze-dried Offal Tissue and of Protein Isolates Therefrom. (g. available lysine/16g N)

Species	Tissue	Freeze-dried	Isolate from S.D.S. extract	Isolated from alkaline extract
Bovine	Lung	8.73	8.02	7.48
	Rumen	6.58	6.30	6.56
	Small Intestine	7.39	6.53	6.33
	Large Intestine	7.64	7.43	6.88
	Lung	8.62	7.38	7.91
	Stomach	7.08	7.28	6.80
	Small Intestine	7.61	6.97	5.74
	Large Intestine	7.05	-	-
	Lung	8.34	8.30	7.79
	Stomach	8.33	7.18	6.20
	Small Intestine	7.81	6.87	7.28
	Large Intestine	7.93	-	-

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