

ANIMAL WASTES. I. EFFECT OF PROCESSING ON THE CHEMICAL AND PROTEIN NUTRITIONAL VALUE OF CALF STOMACH¹

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SUMMARY

The nutritive value of calf stomach waste from rennet production was assessed. The by-product was either drum-dried at the industry (DDSW) or mildly dried (60°C) in a ventilated oven at the laboratory (MDSW). Part of the sample treated at the laboratory was autoclaved before drying (ASW). The protein and ether extract concentrations ranged from 34.25% to 44.31% and from 31.14% to 38.95%, respectively, and were lower in

Manuscrito modificado recebido: 20-4-81.

- 1 This work was supported by grants from the Financiadora de Estudos e Projetos (FINEP-82-B) and from the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq-SIP/14001).
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DDSW than in the other two samples. The ash content which ranged from 16.04% to 27.38%, was higher in the DDSW sample. Methionine, cystine, and available lysine were lower in the DDSW by-product than in the other two samples. Lysine availability was affected by the drum-drying and autoclaving procedures. Tryptophan was shown to be the limiting amino acid in all samples. Nutritive value, assayed both in DDSW and ASW, was lower in DDSW when compared with ASW or with casein diets as far as PER is concerned. The digestibility was shown to be ranked in increasing order for DDSW, ASW, and casein. In conclusion, the results indicate that the waste from rennet production may be recommended as an inexpensive source of protein for animal feeding.

INTRODUCTION

Agriculture is the main source of nutrients for human and animal consumption. Man keeps feeding animals with grains in order to produce meat and other kinds of foods. For this purpose, however, the animals compete with man for grain (1).

The recycling of animal wastes could be a way of increasing the production of animal protein at a low price. Animal wastes have been extensively studied (2-5). This effort is an indication of an attempt to produce protein from sources that, in general, contain this nutrient of good nutritional quality.

Heat processing of the wastes may alter the nutritional quality of their proteins through Maillard reactions (6). Therefore, the goal of the present work was to assess chemically and nutritionally an animal waste from rennet production that has been buried after being roughly dried. This constitutes part of a broader study (4, 5) which pursues the assessment of by-products that have been discarded or misused without any further technical procedure.

MATERIAL AND METHODS

The material used in this work was a calf stomach waste, by-product of rennet extraction from "BIOBRAS— Bioquímica do Brasil S/A— Montes Claros, MG, Brasil".

The stomach waste was received either already drum-dried at the factory (DDSW) or frozen. The latter was thawed and after discarding the water, divided in two lots. The first one (ASW) was autoclaved at 120°C for 20 minutes, and then dried in a ventilated

oven at 60°C for 20 hours. The second one (MDSW) was dried directly in a ventilated oven at 60°C for a period of 30 hours.

All three samples were powdered in a laboratory mill equipped with a 20-mesh sieve.

Chemical Analyses

Moisture, fat, ash, calcium, and nitrogen were determined according to the procedure recommended by the Association of Official Analytical Chemists (7).

Phosphorus content was determined as reported by Harris (8), and the amino acid content was measured in a Beckman 120 amino acid autoanalyzer, according to the method of Spackman, Stein and Moore (9). Tryptophan (10) and free ϵ -amino group of lysine (11) were evaluated as recommended.

Biological Assays

Weanling male rats of the Holtzman strain 21-24 days of age were used for assessing nutritional quality of the dietary protein. Eighteen rats with approximately the same initial body weight were randomly distributed into three groups and assigned to the diets described in Table 1. The rats were kept individually in suspended wire cages and they received food and water *ad libitum*. Food consumption and body weight were registered weekly.

Protein nutritional values were assessed by the protein efficiency ratio index (PER). The experiment was run for 28 days. At the end of this period, total weight gain and protein intake of each animal were registered for PER determination. Feces of each animal were collected from the beginning to the end of the experiment for evaluation of apparent digestibility (Dapp). Both indices were determined according to the ratios:

$$\text{PER} = \frac{\text{Weight gain (g)}}{\text{Ingested protein (g)}}$$

$$\text{Dapp} = \frac{\text{Ingested nitrogen (g)} - \text{Fecal nitrogen (g)}}{\text{Ingested nitrogen (g)}} \times 100$$

All results were submitted to analysis of variance and comparisons among the means were done according to the Tukey test (12).

TABLE 1
COMPOSITION OF THE DIETS WITH CASEIN (CONTROL), AND
WASTES, AS PROTEIN SOURCES

Ingredients	Control g	ASW g	DDSW g
Casein	120.5	—	—
ASW*	—	237.4	—
DDSW*	—	—	291.9
Cornstarch	580.3	563.3	523.3
Sucrose	100.0	100.0	100.0
Corn oil**	146.2	57.6	59.2
Salt mixture***	50.0	50.0	50.0
Vitamin mixture***	10.0	10.0	10.0
Cellulose	10.0	10.0	10.0
Protein (o/o)	10.0	10.0	10.8
Energy (kcal/kg)	4,483	4,403	4,243

* See "Material and Methods" for preparation of the samples: autoclaved stomach waste (ASW) and drum-dried stomach waste (DDSW).

** Total lipid content in each diet was 15o/o.

*** For composition, see (7).

RESULTS

Chemical Analysis

Table 2 shows the per cent composition of the products obtained from the calf stomach waste. The drum-dried at the factory material (DDSW) presented a lower content of proteins and ether extract than the other samples, but it had the highest ash concentration. The MDSW and ASW by-products exhibited a comparable composition (Table 2).

The amino acid composition of the three samples and the content of available lysine are presented in Table 3. As the data reveal, threonine, methionine, cystine, tyrosine and tryptophan were lower in the DDSW than in the other two samples (ASW and MDSW).

TABLE 2

CHEMICAL COMPOSITION OF DRUM-DRIED STOMACH WASTE (DDSW), AUTOCLAVED STOMACH WASTE (ASW), AND MILDLY DRIED STOMACH WASTE (MDSW)*

Samples	Moisture o/o	Protein (Nx6.25) o/o	Ether extract o/o	Ash o/o	Calcium o/o	Phosphorus o/o
DDSW	6.80	34.25	31.14	27.38	0.50	0.47
ASW	3.50	42.12	38.95	16.80	0.58	0.47
MDSW	4.27	44.31	35.97	16.04	0.58	0.48

* See "Material and Methods" for preparation of the products.

The levels of available lysine were also lower than the total lysine content in the DDSW and ASW. Tryptophan is the limiting amino acid in all three samples followed by sulfur-containing amino acids in the DDSW and ASW, when compared with whole egg proteins, as reported by Payne (13).

Biological Assay

The results of initial body weight, food intake, weight gain of the experimental animals and protein efficiency ratio, as well as the apparent digestibility of the samples analyzed, are shown in Table 4. The amount of ingested food was statistically equal in all three groups. In this case, the values for weight gain, PER, and apparent digestibility were lower in the DDSW group than in the casein and ASW groups. The latter two groups had similar values for all the above-mentioned indices, except for apparent digestibility which was lower in the ASW than in the casein group.

DISCUSSION

The stomach waste studied in this work exhibited nutrient levels comparable with those of other animal products used as feed (4, 14). There was, however, a very high concentration of

TABLE 3

**AMINO ACID CONTENT OF DRUM-DRIED STOMACH WASTE
(DDSW), AUTOCLAVED STOMACH WASTE (ASW), AND
MILDLY-DRIED STOMACH WASTE (MDSW)***

Amino acid	DDSW	ASW	MDSW
	(g/100 g recovered protein)		
Lysine	5.30	5.92	5.40
Available lysine	3.80	4.90	5.13
Histidine	1.69	1.40	1.66
Arginine	7.00	6.63	6.35
Aspartic acid	8.67	8.74	9.04
Threonine	4.19	4.65	4.93
Serine	4.21	4.33	4.57
Glutamic acid	13.68	13.98	13.81
Proline	9.08	8.34	7.89
Glycine	11.74	10.24	9.76
Alanine	6.01	5.84	6.25
Valine	5.46	5.15	5.25
Methionine	1.27	2.21	2.13
Cystine	1.23	1.89	1.96
Isoleucine	3.49	3.72	3.75
Leucine	7.03	7.72	7.63
Tyrosine	3.19	3.72	3.74
Phenylalanine	4.19	4.27	4.28
<u>Tryptophan</u>	<u>0.67</u>	<u>0.74</u>	<u>0.77</u>
<u>Ammonia</u>	<u>1.79</u>	<u>0.74</u>	<u>0.74</u>

* See "Material and Methods" for preparation of the products.

ashes (14) that could have been due to the procedure followed by the manufacturer to produce the rennet. The method which the industry applies to obtain rennet leaves the by-product, which has been buried, with a large amount of salt and inert material used for the enzyme extraction. This assumption seemed to be confirmed by the fact that the calcium and phosphorus contents were equal for all three products.

TABLE 4

INITIAL BODY WEIGHT, FOOD INGESTED, BODY WEIGHT GAIN OF RATS, PROTEIN EFFICIENCY RATIO (PER) AND PROTEIN APPARENT DIGESTIBILITY (Dapp) OF DIETS WITH CASEIN (CONTROL) AND STOMACH WASTES AS PROTEIN SOURCES*

Diets	Initial body weight g	Food ingested g	Weight gain g	PER	Dapp o/o
Control	45.5 ± 2.3	309.5 ± 25.3 ^a	93.3 ± 15.4 ^a	3.00 ± 0.35 ^a	92.19 ± 0.88 ^a
DDSW	45.5 ± 2.9	290.6 ± 27.3 ^a	57.9 ± 13.1 ^b	1.97 ± 0.32 ^b	81.97 ± 2.85 ^b
ASW	45.5 ± 2.7	305.8 ± 7.3 ^a	81.7 ± 8.5 ^a	2.67 ± 0.35 ^a	85.16 ± 1.07 ^c

* See "Material and Methods" for composition of the diets and handling of the by-products. Mean ± SD with the same letter superscript are statistically equal at the 5% level of significance.

The attempt to reduce ashes by discarding the water after thawing the frozen sample received from the factory was not entirely satisfactory, in spite of a reduction of 50% in the ash concentration. Further studies are therefore deemed necessary to establish if the high content of ashes has any adverse effect on the biological quality of the stomach waste proteins, as shown by its PER and digestibility.

Heat treatment by autoclaving did not alter the amino acid composition of the product, but it did decrease lysine availability. The procedure of drying the product at the industry, however, seems to have been more severe and to have promoted a decrease in the available lysine, threonine, methionine, cystine, tyrosine, and tryptophan contents. Severe heat treatment has been shown to alter the protein quality of the food (15). The decrease in the available lysine can be due to reaction of the amino group with other substances (16, 17).

The severe treatment used to dry the product at the factory also destroyed the sulfur-containing amino acids, making them the second limiting amino acids, following tryptophan. When the stomach was submitted to mild treatment at the laboratory, again the first limiting amino acid was found to be tryptophan, followed by isoleucine. The biological assay also showed the material produced by the manufacturer to be worse than either casein or the product obtained in the laboratory for all indices used. This could be anticipated by the results from chemical analyses. The severe heat treatment may not be the only reason for the inferior quality of the DDSW product. The high-ash content in this product may also have adverse nutritional effects. Further animal trials, using improved product, should therefore be performed.

Despite the fact that tryptophan was the limiting amino acid with 46% of that of whole egg, the products seem to have enough of it to grow rats, since the values for PER in the ASW group were comparable to those in the casein group.

In summary, the product that is discarded by industry, in a country that lacks good quality protein, was shown to be useful for animal feeding, in fact, even better than others already used for this purpose (4). Aside from this fact, the product can be improved by treating it properly in order to preserve its nutritional quality.

RESUMEN

SUBPRODUCTOS ANIMALES. I. EFECTO DEL PROCESAMIENTO SOBRE LA COMPOSICION QUIMICA Y EL VALOR NUTRITIVO DE LA PROTEINA DE ESTOMAGO DE TERNERO

Se evaluó el valor nutritivo de los restos de estómago de ternero desechado de la producción de cuajo. En la industria, los subproductos se secaron en desecadora de tambor (DDSW) o bien se secaron levemente en el laboratorio (60°C) en un horno ventilado (MDSW). Parte de la muestra tratada en el laboratorio se sometió al autoclave antes del secamiento (ASW). Las concentraciones de proteína y de extracto etéreo variaron de 34.25% a 44.31%, y de 31.14% a 38.95%, respectivamente, y fueron más bajas en el subproducto DDSW que en las otras dos muestras. El contenido de cenizas, que fluctuó entre 16.04% y 27.38%, fue más alto en la muestra DDSW. El contenido de metionina, cistina y lisina disponible fue más bajo en la muestra DDSW que en las otras dos. Según se comprobó, los procedimientos de secado en tambor y de autoclave afectaron la disponibilidad de lisina. El triptofano demostró ser limitante en todas las muestras analizadas. El valor nutritivo, determinado biológicamente en los subproductos DDSW y ASW, fue más bajo en DDSW, comparado con el de la muestra ASW o con dietas de caseína en lo que al PER se refiere. La digestibilidad varió en orden creciente como sigue: DDSW, ASW y caseína. En conclusión, los resultados indican que los desechos de la producción de cuajo, pueden ser un subproducto a recomendar como una fuente barata de proteína para propósitos de alimentación animal.

ACKNOWLEDGEMENTS

The authors are indebted to Drs. Enio C. Vieira and Marcos Luiz dos Mares-Guia for their helpful suggestions, and to Marcelo Eustáquio da Silva and Cássio Mário F. Costa for their technical help.

They are also indebted to BIOBRAS-Bioquímica do Brasil S/A for providing the samples.

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