

ANIMAL WASTES. II. CHEMICAL AND NUTRITIONAL EVALUATION OF BY-PRODUCTS FROM RENNET AND PROTEASES PRODUCTION¹

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SUMMARY

Drum-dried calf stomach waste (DDSW) from rennet production, after washing with water for salt elimination, as well as drum-dried porcine pancreas waste (DDPW) from protease extraction were used. Their chemical composition and nutritional values were studied. The protein content of DDPW was two-thirds that of the DDSW sample. The amount of ashes (acid soluble and insoluble) in DDPW was twice that of DDSW. Four diets, the protein sources of which were casein, DDSW, DDPW and a mixture of equal parts of both by-products (MSPW) were then prepared. Their nutritive value was assessed in weanling rats through the following parameters: food ingestion, body weight gain, protein efficiency ratio (PER) and apparent protein

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digestibility. The DDSW sample showed the lowest nutritional quality for all parameters measured. The weight gain of rats fed diets containing casein, DDPW, MSPW, and DDSW were, 59.60 ± 8.12 , 84.63 ± 9.89 , 56.22 ± 6.74 , and 20.08 ± 3.72 , respectively. The PER for the same diets were: 2.82 ± 0.33 , 2.67 ± 0.19 , 2.17 ± 0.25 , and 1.30 ± 0.20 , in the same order. The protein digestibility of all experimental diets was about 70%, and that of the control diets, about 90%. As a conclusion, the by-product of protease production from porcine pancreas seems adequate as a protein source for animal feeding, despite its high level of ashes. Also, this by-product appears to be useful for feeding purposes, when mixed with the other animal by-products studied.

INTRODUCTION

Some industrial by-products of animal origin have been discarded or ill-utilized in Brazil (1-3). This attitude deserves attention, since the by-products are good protein sources. Furthermore if the wastes are not duly treated, they can be an agent of pollution.

The previous paper on this subject (1) showed results that recommended the use of calf stomach waste, from rennet production, as a protein source for animal feeding purposes. It was, however, advised that washing of the by-product should be performed before drying, in order to decrease its ash content.

On the present occasion, the manufacturer produced a batch of the by-product, previously washed, as recommended. The goal of this work was to evaluate its nutritive value as well as that of the by-product (pancreas) from protease production for the above-mentioned purposes.

MATERIAL AND METHODS

The materials used in the study reported herein, were calf stomach and porcine pancreas residues, after rennet and protease extraction, respectively. Both were kindly provided by "BIOGRAS-Bioquímica do Brasil S. A.", Montes Claros, MG, Brazil.

At the factory, the stomach by-product was washed with water and then drum-dried, with steam as the source of heat. The porcine pancreas, after protease extraction, was drum-dried as

above, but without any washing. The two samples were received at the laboratory as a fine powder; after their arrival, both drum-dried stomach waste (DDSW) and drum-dried pancreas waste (DDPW) were stored at 4°C.

Chemical Analyses

Moisture, nitrogen, ether extract, and acid soluble and insoluble ashes were determined as recommended by the Association of Official Analytical Chemists (4).

Biological Assays

Weanling male rats of the Holtzman strain, 21-24 days of age, weighing between 41.0 and 43.9 g were used for assessing nutritional quality of the dietary protein. Twenty-four rats were randomly distributed into four groups and assigned to the diets the composition of which is described in Table 1. The rats were kept individually in suspended wire cages, with full 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 covered a 28-day period during which feces of each animal were collected. Total weight gain of each animal was also registered, and the PER and apparent digestibility (Dapp) were calculated 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 L test (5).

RESULTS AND DISCUSSION

Table 2 shows the per cent composition of the by-products studied in this work. The protein level in the drum-dried DDSW,

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

Ingredients	Control g	DDSW g	DDPW g	MSPW. g
Casein	116.0	—	—	—
DDSW	—	190.0	—	—
DDPW	—	—	268.0	—
MSPW*	—	—	—	234.0
Cornstarch	608.0	573.0	523.0	543.5
Sucrose	100.0	100.0	100.0	100.0
Corn oil**	146.0	107.0	79.0	92.5
Salt mixture***	50.0	50.0	50.0	50.0
Vitamin mixture***	10.0	10.0	10.0	10.0
Cellulose	10.0	10.0	10.0	10.0
Protein (‰)	9.62	9.29	9.05	9.65
Energy (kcal/kg)	4,567	4,414	4,204	4,310

* Mixture of equal parts of drum-dried stomach waste (DDSW) and drum-dried pancreas waste (DDPW).

** The total lipid content in each diet was 15‰.

*** For composition, see (4).

material was higher than that reported in the preceding paper (1). The fat (ether extract) (22.63‰) and ash contents (15.15‰) were lower than those reported previously (31.4 and 27.38, respectively, for fat and ash), when a similar sample was used without washing before drying (1). This washing of the by-product is probably the cause of the decreased contents. The washing, however, was not sufficient to completely eliminate the inert material (acid insoluble ash) utilized by the industry to produce rennet.

Table 2 also shows the composition of DDPW, another by-product that is usually discarded as waste. The protein and ash levels were very high (6). The proportion of acid insoluble ash was about 90‰ of the total ash content. DDPW was not washed

TABLE 2

**CHEMICAL COMPOSITION OF DRUM-DRIED STOMACH
WASTE (DDSW) AND DRUM-DRIED PANCREAS WASTE (DDPW)***

Component	DDSW %	DDPW %
Moisture	16.38	11.30
Nitrogen	7.81	5.40
Protein (N x 6.25)	48.81	33.73
Ether extract	22.63	26.50
Ashes:		
Acid insoluble	14.00	28.50
Acid soluble	1.15	3.50

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

before drum-drying.

The nutrient levels found in these by-products are comparable to those reported in the literature (3) which are utilized, or potentially utilized for food and feed purposes.

Table 3 shows the results of the study on nutritional evaluation of the by-products and of a mixture of equal parts of them carried out, as stated, in 24-day-old weanling rats of the Holtzman strain. Data on food ingested and weight gain were registered weekly in an experimental period of four weeks and, finally, PER and apparent digestibility were calculated.

The ingestion of the diet, the protein source of which was DDSW, was significantly lower than that of all other diets tested. In addition, weight gain, PER, and protein apparent digestibility showed the lowest values.

Table 3 shows that the nutritive value of DDSW was not improved by washing as recommended in a previous paper (1). The recommendation was a meaningful one as far as elimination of ash was concerned, but it is likely that the washing also removed some soluble protein fraction better balanced in essential amino acids. Therefore, if there is a dietary imbalance in essential amino acids, a decrease in food ingestion and a lower value for PER are to be expected (7, 8).

TABLE 3

INITIAL BODY WEIGHT, FOOD INGESTED, BODY WEIGHT GAIN OF RATS, PROTEIN EFFICIENCY RATIO (PER) AND PROTEIN APPARENT DIGESTIBILITY (Dapp) OF DIETS THE PROTEIN SOURCES OF WHICH WERE: CASEIN (CONTROL), AND THE WASTES*

Diets	Initial body weight g	Food ingested g	Weight gain g	PER	Dapp
Control	42.5 ± 4.7	219.8 ± 18.2 ^a	59.60 ± 8.12 ^a	2.82 ± 0.33 ^a	90.46 ± 1.48 ^a
DDSW	41.0 ± 2.1	167.6 ± 24.1 ^b	20.08 ± 3.72 ^b	1.30 ± 0.20 ^b	67.17 ± 6.63 ^b
DDPW	43.9 ± 2.4	349.5 ± 17.5 ^c	84.63 ± 9.89 ^c	2.67 ± 0.19 ^a	72.15 ± 1.13 ^{bc}
MSPW	42.7 ± 4.6	268.0 ± 17.0 ^d	56.22 ± 6.74 ^a	2.17 ± 0.25 ^c	76.35 ± 1.50 ^c

* See "Material and Methods" for preparation of the products and diets. Means ± SD with the same letter superscript are statistically equal at the 5% level of significance.

The decreased digestibility and PER indices when compared to previous results (PER 1.97 and Dapp = 81.97%) of the DDSW (1) corroborate the suggestion that some protein fractions were lost during washing and that the remaining ones might be less digestible and of poorer nutritional quality. Aside from this fact, the adverse processing effect on the quality of the remaining protein can not be ruled out.

The highest amount of food ingestion was observed for the group which received the diet based on drum-dried pancreas waste (DDPW). The weight gain of this group was higher than that of the casein one, but the PER was statistically equal in both groups. The digestibility, however, was significantly lower than that of casein and similar to DDSW. The by-product used to prepare the diet was not washed before drum-drying; therefore, its content of ashes (32%) was high, even higher than that of DDSW (27.38%) previously reported (1). In spite of the fact that digestibility of the protein of DDPW is not comparable to casein, as far as weight gain and PER are concerned, the nutritive value of the proteins of this by-product suggests that it could very well be recommended as a good protein source for the feeding of monogastric animals.

In order to try an improvement in the nutritional quality of the DDSW protein, a diet based on a mixture containing equal parts of DDSW and DDPW was prepared. The results showed intermediate values for food ingestion, weight gain, and PER when compared to figures derived from DDSW and DDPW.

This study, therefore, indicates that for animal feeding purposes, the by-product obtained from protease production is better than that of rennet extraction. Both by-products, however, can be utilized to prepare rations when a mixture of them is used. The nutritional quality of the mixture would be better if the proportion of DDPW were higher than that used in the present work.

It seems that with further minor technical treatments, the by-product would be very useful for animal feeding purposes.

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RESUMEN

DESECHOS DE ORIGEN ANIMAL. II. EVALUACION QUIMICA Y NUTRICIONAL DE SUBPRODUCTOS DE CUAJO Y DE PRODUCCION DE PROTEASAS

Se sometió a estudio la composición química y el valor nutritivo de los restos de estómago de ternero después de la producción de cuajo. La muestra fue lavada con agua para eliminar las sales y luego secada en un secador de tambor (DDSW). Se estudiaron también los restos de la extracción de proteasa de páncreas de cerdo después de secados en un secador de tambor (DDPW). El contenido de proteínas del DDPW fue dos tercios del determinado en la muestra DDSW. La cantidad de cenizas (ácido soluble e insoluble) en el material DDPW fue el doble de la que acusó la muestra DDSW.

Se prepararon cuatro dietas cuyas fuentes de proteína fueron caseína, DDSW, DDPW y una mezcla por partes iguales de ambos subproductos (MSPW). Su valor nutritivo se evaluó en ratas recién destetadas a través de los siguientes parámetros: ingestión de alimento, ganancia de peso corporal, índice de eficiencia proteínica (PER), y digestibilidad aparente de proteína. Para todos los parámetros medidos se encontró que el subproducto DDSW tenía una menor calidad nutricional. El aumento de peso de las ratas alimentadas con las dietas que contenían caseína, DDPW, MSPW y DDSW fue de 59.60 ± 8.12 , 84.63 ± 9.89 , 56.22 ± 6.74 y 20.08 ± 3.72 , respectivamente. El PER para las mismas dietas fue de 2.82 ± 0.33 , 2.67 ± 0.19 , 2.17 ± 0.25 y 1.30 ± 0.20 , en ese mismo orden. La digestibilidad de proteínas en todas las dietas experimentales fue alrededor del 70% mientras que en la dieta control ésta fue de más o menos 90%.

Como conclusión, parece ser que los subproductos de la producción de proteasa de páncreas de cerdos son muy adecuados como fuente de proteínas para alimentación animal, a pesar de su alto contenido en cenizas. Ajeno a ello, este subproducto también demostró ser útil para propósitos alimentarios, al ser mezclado con el otro subproducto animal sometido a estudio.

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