HATCHERY WASTE: NUTRITIONAL EVALUATION OF NON-HATCHED EGGS[1]

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SUMMARY

Hen's non-hatched eggs were processed by boiling for 30 minutes, milling in a meat grinder, and drying at 60°C with continuous ventilation. The product contained 36°/o of protein, 27°/o of ether extract, 17°/o of ash, 10°/o of calcium, and 0.6°/o of phosphorus. The quality of the protein was comparable to that of a reference casein and of fresh egg meal, as determined by protein efficiency ratio and apparent net protein utilization.

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The apparent digestibility of non-hatched egg meal and of the reference casein were the same but lower than that of fresh egg meal. The non-hatched egg meal showed no toxicity.

INTRODUCTION

There are many reports on the processing of avian by-products and their utilization in animal feed. Poultry by-products meal, poultry offal meal, hydrolyzed feather meal, blood meal, and manure have been recycled and incorporated into rations for birds, swine, pet animals, etc.

Few reports on the utilization of hatchery wastes have appeared. Willman *et al.* (1) found that 90% of the protein from non-hatched eggs, either raw or cooked, are digested by swine. The effect of time of incubation on the nutritive value of fertile eggs was reported (2). Kempster (3) fed chickens with dehydrated hatchery wastes at levels of 3-6% in the diet and observed no effect of the product on avian growth. Even though this waste contains a high level of calcium, apparently growth is not affected when it is present in diets at reasonable levels (4-6). Panda, Satyanarayana Rao and Srinivasan (7) prepared hatchery waste by cooking for one hour, grinding, and drying it at 80°C; the product was used as swine feed. Srinivasan and Jayaraman (8) prepared a meal from non-fertilized eggs, determined its amino acid composition and found it suitable for poultry rations.

This paper presents a method for preparing non-hatched egg meal; the chemical composition and nutritive values of the preparation were determined.

MATERIALS AND METHODS

Raw Material

Hatchery waste was obtained from Granja Igarapé (Igarapé - Minas Gerais) and consisted of non-hatched eggs (either non-fertile or with dead embryos at several stages of development). This material was transported to the laboratory, kept under refrigeration, and processed within 24 hours. Normal fertile fresh eggs were obtained from the same source.

Processing

Both fresh and rejected eggs were processed separately as follows. The material after having been cooked for 30 min at 95°C was milled in a meat grinder and then dried at 60°C with continuous ventilation. The product thus obtained was ground to a fine powder in a grinding mill and kept at 4°C in plastic bags.

Analysis of the Meal

Moisture, total nitrogen, protein nitrogen, ether extract, fiber, ash, non-nitrogenous extract, and calcium were determined according to AOAC (9). Phosphorus was determined according to Harris (10). The method of Spackman, Stein and Moore (11) was used for the amino acid analyses after hydrolysis of the defatted material with 6N HCl for 24 hours at 110°C under vacuum. Sulfur-containing amino acids were determined after hydrolysis with performic acid, according to Hirs (12).

Toxicity Test

Toxicity was assayed according to Campbell (13). Three lots of four rats were fed a 20% protein diet consisting of: (a) non-embryonated egg meal without the shells; (b) embryonated egg meal with shells; (c) whole non-hatched egg meal. A diet whose protein source was casein was used as control. The animals were maintained in individual cages, receiving water and diet *ad libitum,* for ten days. After this period, the weight gain and food intake were measured.

Determination of Nutritive Value

Weaned 21 day-old male Holtzman rats were used. The animals were fed on commercial diet for two days. They were randomly divided into three groups of five animals and one group of four animals in such a way that variation of weight in the same group was not higher than 3.5 g and the average difference between groups was not higher than 0.5 g. The initial average weight varied between 36.8 and 37.3 g. The rats in the group of four were killed with chloroform at the beginning of the experiment

and their carcasses were dried at 105°C up to constant weight for apparent net protein utilizacion (NPU_{app}) determination (14). Nitrogen and ether extract were determined in the dry carcass (9).

The animals from the other groups were reared in individual cages, fed *ad libitum* diets during 28 days. The composition of the diets is shown in Table 1. Food consumption and weight gain were recorded weekly. Protein efficiency ratio (PER) was calculated as follows:

$$PER = \frac{\text{weight gain (g)}}{\text{ingested protein (g)}}$$

Apparent digestibility (D_{app}) (15) was measured by adding ferric oxide (200 mg/100 g of diet) as a marker in the last week of experiment. The feces were collected daily, pooled for each animal at the end of the week, dried at 105°C for 24 hours, and powdered. Total nitrogen was determined and the apparent digestibility was calculated with the equation:

$$D_{app} = \frac{\text{absorbed nitrogen (g)}}{\text{ingested nitrogen (g)}} \times 100$$

Apparent net protein utilization (NPU_{app}) was calculated as follows:

$$NPU_{app} = \frac{\text{gained nitrogen (g)}}{\text{ingested nitrogen (g)}} \times 100$$

where *gained nitrogen*, based on carcass analysis, is equal to the difference between body nitrogen determined at the end of the experiment and body nitrogen at the beginning (zero time). The latter is equal to the average of body nitrogen content of initial control group per gram of body weight, multiplied by the body weight of each experimental animal at zero time. The variation of lipids in carcass was determined in a similar fashion.

Statistical Analysis

The statistical analysis was done in an Olivetti computer with

TABLE 1

COMPOSITION OF THE DIETS

Ingredients	Diets (g)		
	A	B	C
Salt mixture*	5.00	5.00	5.00
Vitamin mixture*	1.00	1.00	1.00
Starch**	65.00	64.00	68.00
Cellulose	1.00	1.00	6.00
Cod liver oil	1.00	1.00	1.00
Corn oil	–	–	7.00
Fresh egg meal	27.00	–	–
Non-hatched egg meal	–	28.00	–
Casein***	–	–	12.00
Protein content, °/o	10.00	9.84	10.21
Calcium content, °/o	4.65	4.83	1.64
Phosphorus content, °/o	0.595	0.574	0.572

* AOAC (9).

** Maizena, kindly supplied by Refinações de Milho Brasil S. A.

*** ANRC Reference Casein (Humko Sheffield Chemical Co., Norwich, New York).

the program 101/A (16). All data were analyzed by the Student "t" test.

RESULTS AND DISCUSSION

Production of Meals

Both fresh egg and non-hatched egg meals were of a light yellow color and were not unpleasant as to odor. When stored for six months, no change in odor or color was observed. About 32°/o of non-hatched egg weight was recovered as meal.

Analysis of the Meals

Table 2 shows the composition of the meals and the results reported in the literature. Compared with meals obtained from this kind of material, the non-hatched egg meal has a higher protein content. The calcium level is lower in this meal and in that reported by Srinivasan and Jayaraman (8) since the shell content in those meals is lower . Kempster (3), Wisman (5), and Panda, Satyanarayana Rao and Srinivasan (7) used total offal meal.

The amino acid composition is shown in Table 3 together with some results from other authors. There were marked differences between the non-hatched egg meal and other meals from the literature. Table 3 shows that the present meal has a higher content in all esential amino acids than the meals described by Wisman (5) and Panda, Satyanarayana Rao and Srinivasan (7).

Biological Assay

Food ingestion and growth rate were nearly the same for the three groups studied. Table 4 shows the weight gain, food consumption, protein efficiency ratio, apparent digestibility, apparent net protein utilization, and lipid gain for the three diets used. There was no significant difference among the three groups for most parameters measured. Significant differences were found in values of apparent digestibility between groups on diets with fresh eggs and casein ($P < 0.02$) and between groups on diets with non-hatched egg meal and casein ($P < 0.001$). The quality of the protein from non-hatched egg meal is equivalent to that of fresh egg or casein.

The excess of calcium in the diets containing eggs, apparently, did not cause any ill effects to the animal during the period of observation.

The results presented show that a nutritive meal may be obtained from avian hatchery waste. More research must be done on the long range effect of this product. The biological assays were carried out for a period of only 28 days. The temperature of processing used in this work was around 95°C. Under these conditions no toxicity signs were found. However, for a safer product, an experiment extended over a longer period should be carried out; also an optimum temperature of processing must

TABLE 2

CHEMICAL COMPOSITION OF EGG AND NON–HATCHED EGG MEALS AND OF OTHER OFFAL MEALS TAKEN FROM THE LITERATURE

Meal	Moisture %	% of dry weight						
		Total nitrogen	Protein	Ether extract	Fiber	Ash	Calcium	Phosphorus
Fresh eggs	3.37	6.05	37.92	27.72	0.00	18.42	11.13	0.59
Non-hatched eggs	3.54	5.86	36.65	27.78	0.00	17.87	10.59	0.65
Offal (3)	2.45	3.92	24.50	11.72	–	56.90	20.74	0.48
Offal (5)	–	4.16	26.00	11.40	–	33.74	20.60	0.49
Offal (7)	8.00	5.43	33.90	32.81	–	28.23	19.73	0.45
Non-fertilized eggs (8)	7.00	5.00	31.26	32.34	0.92	27.57	9.10	0.76

TABLE 3

AMINO ACID COMPOSITION OF NON–HATCHED EGG MEAL AND SIMILAR PRODUCTS TAKEN FROM THE LITERATURE (g/100 g OF PROTEIN)

Amino acids	Non-hatched egg meal	Offal meal (6)	Offal meal (7)	Fresh egg (16)
Arginine	6.4	4.8	6.0	6.6
Glycine	5.6	5.5	–	–
Histidine	2.0	2.0	1.0	2.4
Isoleucine	4.6	3.6	4.3	6.6
Leucine	8.6	6.1	3.7	8.8
Lysine	6.6	4.1	5.5	6.4
Methionine	3.3	1.9	2.8	–
Cystine	2.6	1.1	2.5	–
Methionine + cystine	5.9	3.0	5.3	5.5
Phenylalanine	6.0	3.5	5.8	5.8
Threonine	4.3	3.4	–	5.1
Tryptophan	–	1.3	0.8	1.6
Valine	6.3	5.0	4.8	7.3
Tyrosine	4.1	2.3	–	4.2
Alanine	5.5	–	–	–
Aspartic acid	9.3	–	–	–
Glutamic acid	15.0	–	–	–
Proline	4.0	–	–	–
Serine	7.2	–	–	–

be searched to secure both the good quality of the protein and the safety of the product.

SUMARIO

Processaram-se ovos não eclodidos de galinha por fervura durante 30 minutos, trituração em um moedor de carne e secagem a 60°C em estufa ventilada. O produto continha 36°/o de proteína, 27°/o de extrato etéreo, 17°/o de cinza, 10°/o de cálcio e 0.6°/o de fósforo. A qualidade da proteína do produto foi

TABLE 4

WEIGHT GAIN, FOOD INTAKE, PROTEIN EFFICIENCY RATIO (PER), APPARENT DIGESTIBILITY (D_{app}), APPARENT NET PROTEIN UTILIZATION (NPU_{app}), AND LIPID GAIN FOR DIETS WITH DIFFERENT PROTEIN SOURCES

Diets	Initial weight (g)	Food intake (g)	Weight gain (g)	PER	D_{app}	NPU_{app}	Lipid gain
A	37.30 ± 0.40*	375.40 ± 33.30	127.90 ± 13.60	3.38 ± 0.07	84.23 ± 1.45	59.1 ± 4.3	15.68 ± 4.94
B	36.80 ± 0.60	400.60 ± 9.10	136.90 ± 7.00	3.47 ± 0.11	81.82 ± 0.68	64.1 ± 5.3	17.05 ± 3.22
C	37.00 ± 0.60	369.70 ± 12.50	128.30 ± 9.10	3.39 ± 0.14	89.27 ± 0.66	64.1 ± 4.1	18.54 ± 3.23

A = Fresh egg meal.
B = Non-hatched egg meal.
C = Casein.
* Mean ± standard error of groups of five male rats.

comparável aquela de uma caseína de referência e a de farinha de ovo fresco, avaliada pelo coeficiente de utilização proteica (PER) e pela utilização líquida de proteína aparente (NPU_{app}). As digestibilidades aparentes da farinha de ovos não eclodidos e a da caseína de referência foram semelhantes, porém menores do que a de farinha de ovo fresco. A farinha de ovos não eclodidos não mostrou toxicidade.

RESUMEN

DESPERDICIO DE INCUBADORAS: EVALUACION DE HUEVOS NO REVENTADOS

Se procesaron por ebullición durante un período de 30 minutos, huevos de gallina, incubados pero no reventados, luego se molieron en un molino de carne y se secaron a la temperatura de 60°C con ventilación continua. El producto contenía 36°/o de proteína, 27°/o de extracto etéreo, 17°/o de cenizas, 10°/o de calcio y 0.6°/o de fósforo. De acuerdo con la razón de eficiencia proteica y utilización proteica neta aparente, se encontró que la calidad de la proteína era comparable a la caseína de referencia y a la de harina de huevo fresco. La digestibilidad aparente de la harina de huevos no reventados fue la misma que la de caseína de referencia, pero menor que la de harina de huevo fresco. La harina de huevos no reventados no acusó ninguna toxicidad.

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