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ORIGINAL PAPER

Liquid Protein Feedstuff from Freshwater fish by-products as a Component of Animal Feed

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Abstract

The influence of the technology of freshwater fish processing on liquid protein feedstuff is investigated. By determining chemical and nutritive values of raw material and final product, as well as, changes on proteins during thermal treatment, conservation and hygiene of final product it can be concluded that a protein feedstuff of a superior quality, in accordance with regulations, can be made.

Keywords: fish, liquid protein feedstuff, thermal treatment, chemical characteristics, nutritive value, hygiene

Introduction

One way of solving ecological problems related to great quantities of by-products in food processing is incorporating them into animal feed. In every country, the basic condition for intensive cattle raising is providing own raw material for animal feed. By-products, as well as whole fish, in fresh water fish breeding are inconvenient as a human food, but from a nutritive point of view, those products can be a valuable source of proteins, fats and minerals in animal feed [1, 2, 3, 4, 5, 6, 7]. From this type of raw material fish powder and liquid protein feedstuff – fish mash can be produced. Recent investigations of Roseg and co [8], Ristić [4, 9, 10] and Kormanjoš and co. [11] pointed out that fish by-products applied to organic carrier can be dried and pelleted successfully and this is satisfactorz as far as ecologz, technological processing and final product quality are concerned.The basic idea related to liquid protein feedstuff is the decrease in investment costs, energy consumption and retaining protein quality, particularly lysine, methionine and cystine content leading us to investigate this way of processing, as well as, the quality of the product.

Material and Methods

a) Raw material

Raw material for liquid protein feedstuff consists of caracas fish (*Carasius auratus gibelio Bloch*) weighing round 60 g and other kinds of nondisered fish (5%) from fish ponds Raw material structure (95 : 5%) is in accordance with the structure of those kinds of fish in our fish ponds.

b) Technology of fish processing into liquid protein feedstuff

Raw material consisting of small caracas and other nondesired fish is crushed, water is added and then autoclaved until it reaches a temperature of 120^{o} C and a pressure of 2.5 bar. Processing pressure is kept constant during 10 minutes. Processed material is grinded in a colloid mill and at a temperature of around 80^{o} C pH is adjusted to 3.5 with phosphorus acid. After preservation the fish mash is stored at room temperature (25^{o} C).

c) Methods

Chemical methods

Basic chemical composition, profile of nitrogen fractions, and protein digestibility in acid pepsine are determined according to official AOAC methods [12].

Amino acids are determined in automatic amino acid analyzer LC 5001, by separation on ion exchange resin [13]. Proteins are hydrolyzed 23 h at 110^{o} C. Cystine and methionine are previously oxidized by performic acid (15 h at 2^{o} C) [13]. Triptophane is determined by spectrophotometry [14].

Biological activity of amino acids is determined according to Akerson & Stahman [15].

Microbiology

Samples of liquid protein feedstuff are incubated on selective medium immediately after preparation and after 5 days of storing. Bacteria are quantitatively determined by standard procedure of incubation on nutritious and malt agar.

Results and Discussion

Related to animal origin by-products, processing into animal feed, basic technological and parallel to this, ecological problem, is decreasing water and fat in raw material but making an acceptable product concerning its nutritive value and hygiene. Earlier investigations of Marzcali [16], Djordjević and co. [17] and Ristić and co. [18, 19, 20] proved that by processing some raw material of animal origin, meat mash that meets a part of animal needs in protein and fatty acids can be produced. This is a simple technology, but concerning investment and ecology it is more convenient, so it is applied to the processing of fish by-products in order to decrease the influence of thermal treatment on proteins and lipids i.e. to retain nutritive value.

Quality of investigated raw material used for liquid protein feedstuff is presented in **Table 1**.

Table 1. Chemical characteristics of combined raw material for liquid protein feedstuff

Chemical parameters	**In sample (%)**	**In dry matter (%)**
Basic chemical composition		
Moisture	76.10	-
Crude protein	15.02	62.85
Crude fat	3.42	14.31
Crude fiber	0.29	1.21
Mineral matters	3.61	15.10
N- free extract	1.65	6.52
Content of essential and semiessental aminoacids	In sample (%)	In protein (%)
Lysine	1.19	7.92
Hisitidine	0.40	2.66
Arginine	0.88	5.85
Threonine	0.74	4.92
Valine	0.67	4.46
Methionine	0.40	2.66
Isoleucine	0.62	4.12
Leucine	1.00	6.66
Phenilalanine	0.59	3.92
Tryptophan	0.16	1.06
Cystine	0.15	0.99
Tyrosine	0.56	3.73
Nitrogen fractions		
Protein nitrogen (%)	2.36	9.87
Nonprot. nitrogen (%)	0.05	0.21
α amino nitrogen (mg %)	72.27	302.38
Protein digestibility (%)	96.58	

High level of protein quality, used as a raw material, is proved by significant share of protein nitrogen in the total nitrogen content, high content of lysine, metionine and cystine in proteins and also a high *in vivo* protein digestibility (96.56), **Table 1**. Content of non-protein nitrogen (0.2% d.m.) is a little smaller than cited by Marošević [21]. Ristić and co. [5, 10] detected similar levels of protein digestibility in the material originated from fresh water fish, as well as, in fish by-products [2, 3, 4, 22].

Quality of liquid protein feedstuff specified by chemical and nutritive characteristics, and microbiology is presented in **Table 2** and **3**, respectively.

Table 2. Chemical characteristics of liquid protein feedstuff

Chemical parameters	**In sample (%)**	**In dry matter (%)**
Basic chemical composition		
Moisture	80.00	-
Crude protein	12.25	61.25
Crude fat	2.97	14.85
Crude fiber	0.25	1.25
Mineral matters	3.09	15.45
N- free extract	1.44	7.20
Content of essential and semiessental aminoacids	In sample (%)	In protein (%)
Lysine	0.93	7.59
Hisitidine	0.35	2.85
Arginine	0.76	6.20
Threonine	0.60	4.89
Valine	0.53	4.24
Methionine	0.31	2.53
Isoleucine	0.51	4.08
Leucine	0.72	5.87
Phenilalanine	0.47	3.83
Tryptophan	0.13	1.06
Cystine	0.11	0.90
Tyrosine	0.44	3.59
Nitrogen fractions	8.90	
Protein nitrogen (%)	1.78	8.90
Nonprot. nitrogen (%)	0.18	0.90
α amino nitrogen (mg %)	78.95	399.75
Protein digestibility (%)	95.67	

Liquid protein feedstuff, **Table 2, is** characterized by high protein content and a suitable content of essential and semi essential amino acid, 47.63 and 4.49 g/100g of protein, respectively, especially for swine and fur coated animals. Heat applied during sterilization and preservation caused minimum changes in proteins, **Table 2** and **3.** Amino acid composition and levels of non-protein and α-amino nitrogen in raw material and product also prove the above-mentioned. Detected changes are in accordance with data reported earlier [4, 9, 10, 23, 24]. Added water to raw material parallel to grinding caused minimum changes. Positive effects of water addition during thermal treatment on protein changes is noticed earlier by Brnetić [25], and Ristić and co. [9, 10] who stated that by thermic treatment of animal origin proteins at temperatures a little higher than 100^{o} C do not degrade proteins, as long as, the moisture content of raw material is higher than 10%.

Pointing out to the small differences between quality parameters of raw material, **Table 1** and final product, **Table 2**, it can be said that applied technological procedure, i.e. processing parameters for liquid protein feedstuff is correct. This statement is supported by small differences in levels of *in vivo* digestibility of proteins in raw material and final product, 96.58 and 95.67, respectively.

Microbiology is one of the basic demands of animal feed quality. Safe content of microorganisms in animal feed is the proof that applied technology is adequate. After autoclaving liquid protein food was sterile and after three days storing it was also safe **Table 3**.

Table 3. Microbiological pattern of liquid protein feedstuff

Total number of saprophyte bacteria (in 1g)	**37.000**
Fungi and moulds (in 1g)	350
Salmonella (in 50g)	Not isolated
Pathogenic microorganisms (in 50 g)	Negative
Sulphoreducing clostridia (in 1 g)	Negative

Saprophyte bacteria, fungi and moulds detected in stored liquid protein food, **Table 3** are a result of later contamination that is inevitable on industrial scale processing. Biological value and pH of liquid protein feedstuff are a suitable media for microorganisms so; prolonged period of its storing is favorable for more intensive microorganism development. Lazor and co [26] and Ristić and co. [18] stated that, concerning shelf-life of meat mash treated with phosphorus acid, satisfying results can be attained during 7 days of storing in the above mentioned conditions.

Conclusion

Based on processing parameters, technology and economics, as well as, liquid protein quality parameters it can be concluded that processing fish by-products into protein food is justified at all places where these processing parameters can be set.

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