ISSN: 0975-8585

Research Journal of Pharmaceutical, Biological and Chemical Sciences

Chemical And Processing Characteristics Of Protein Sludge.

Ivan Fiodorovich Gorlov [1,2]*, Marina Ivanovna Slozhenkina[1,2], Natalya Ivanovna Mosolova[1], Luiza Fergatovna Grigoryan[2], Dinara Valyerevna Murzagaliyeva[2], Olga Andreevna Knyazhechenko[1,2], Natalya Aleksandrovna Prom[2], and Darya Aleksandrovna Mosolova[3].

[1]Volga Region Research Institute of Manufacture and Processing of Meat-and-Milk Production, Volgograd, Russia.
[2] Volgograd State Technical University, Volgograd, Russia.
[3] Plekhanov Russian University of Economics, Moscow, Russia.

ABSTRACT

The data on the secondary products of beer production and their further processing has been summarized. The physicochemical and microbiological indicators of a secondary product in beer production, i.e., protein sludge are presented. Experimental data proving that protein sludge is a valuable raw material and can be used as an additional protein component. Advantages and disadvantages of protein sludge have been determined. Model samples of sausage filler have been developed to determine the optimal amount of protein supplement. The physicochemical parameters of the samples indicated that the protein content in the experimental sample was higher by 2.2% and fat was lower by 0.8% than in the control one. The amino acid profiles of the compared samples showed that protein sludge made up the deficiency of some amino acids, which in turn increased the biological value of the finished meat product. It has been found that combining protein sludge and the "Glimalask" food additive enabled not only reducing bitter flavouring, but also improved color developing and increased storage stability, as the organic acids that make up the composition have a microstatic effect. Thus, in the course of the work, the feasibility of brewing waste being applied in sausage technology has been confirmed.

Keywords: Amino acid composition, Brewing production, Meat products, Nutritional value, Protein sludge.

Corresponding author

ISSN: 0975-8585

INTRODUCTION

Today, special attention is paid to the ecologization of the food industry; its purpose is the development of environmentally friendly and energy-saving technologies based on the rational use of virgin raw materials, integrated processing and safe disposal of secondary raw materials from all processing enterprises. At the same time, as noted any processing production must ensure manufacturing of high-quality competitive products at an affordable price [1, 2]. The brewing industry is no exception, and the problem of creating safe, waste-free and cost-efficient technologies is also relevant.

Wastes subjected to complex processing and used to obtain valuable food components are defined by the term "secondary material resources." Highlighted by authors, that at the present stage of food technology development, the previously widespread term "waste" is not acceptable any more, since innovations in engineering and technology make it possible to use almost any by-products [3]. The issue of full and rational use of secondary material resources in the food industry exists in all countries with developed food industry[1].

The beer production produces waste and secondary products that must be removed or disposed. Few enterprises manage to remove some of these wastes at still relatively low costs, but constantly growing costs force the enterprises to more and more independently dispose of them.

The technology of beer production includes the germination of barley grains to produce malt, followed by its drying and grinding. Next, the mashing process takes place, when crushed malt obtained is poured with water and stepwise heated; meanwhile the enzymatic hydrolysis of starch is carried out with sugars being formed. The resulting mash is pumped into the filter tank, where the spent grains and wort are separated, then heated to 100°C with hop added, precipitated in a hydrocyclone and cooled before being transferred to fermentation tanks, where diluted yeast culture is added. They convert sugar into alcohol. After the beer fermentation, it is incubated and filtered.

In beer production of that kind, for every 1000 tons of finished product there are about 170 tons of waste of spent grains, protein sludge, spent yeast, etc. The bulk is beer spent grains that makes 80-85%. All of these products contain more than 25% protein and are mainly sold as animal feed additives.

Also underlined that the main application areas of beer spent grains are the feed and food industries. In agriculture Rudenko E. Yu [6] underlined, raw brewer's grain most often serves as an additive to galactogenic and protein feeds for farm animals and poultry instead of meat-and-bone meal. At present, as noted Volotka F.B.[7], based on brewer's grains, feed and feed additives have been developed for various species and age groups of farm animals and poultry [4, 5].

Some scientific works are known to have investigated the prospects for the brewing wastes to be applied in various industries, as well as for enrichment of feed, in particular fish food. Protein sludge used in food is not well understood yet [8, 9, 10].

The protein sludge still contains wort that can be extracted and therefore, at most breweries, suspensions are reused, i.e., pumped to the filtration tank to obtain wort and separate protein-rich suspensions of high nutritional value. Protein sludge consists of coagulated high molecular weight proteins, protein-tannin complexes, hop resins, minerals and lipids, but also contains a large amount of bitter substances, so it is either disposed of, or added in small quantities to grains for animal feed. Earlier studies showed the prospects for brewer's grains to be used in human food technology. It was recommended and tested as an additive in the production of meat and semi-finished products [11, 12]. However, protein sludge is no less valuable raw material and it is necessary to evaluate its processing potential, as well as its feasibility in the meat products technology.

MATERIALS AND METHODS

The object of the study was the protein sludge obtained at the brewery production OOO "Shield" in the city of Volgograd. The protein sludge has thick consistency, sweet-bitter taste and smell of brewing malt; it is light brown in color. The samples of semi-smoked sausages were elaborated to study the feasibility of this component.

To determine the prospects for the protein sludge to be used in the technology of sausage products and its processing potential, in a laboratory at the Volga region research institute of manufacture and processing of meat-and-milk production, a number of studies were conducted to define weight fraction of moisture according to GOST R 54951-2012, weight fraction of protein according to GOST 32044.1-2012, weight fraction of fats according to GOST 13496.15- 97, weight fraction of ash according to GOST 26226-95, amino acid composition according to the technique of measuring the weight fraction of amino acids by the capillary electrophoresis method on the Kapel-105M system and microbiological points according to GOST 10444.15-94 and GOST 10444.12-2013. Comparison with the amino acid composition of the reference protein was performed according to the amino acid scale recommended by the Food Committee of the World Health Organization (FAO / WHO).

RESULTS AND DISCUSSION

Due to the technical characteristics of the production, there were some difficulties in sampling; therefore, the values obtained were minimal for protein sludge. Sludge is a wet product with a short shelf life, so to solve this problem; it should be dried or frozen. In this experiment, the preparation of protein sludge for the study included its spinning to remove loosely bound moisture and drying. A part of the spent grains obtained was poured evenly on a baking sheet with a layer of 10 mm and dried in an oven at a temperature of not more than 60°C, in order to preserve the original biological activity of the final product. So, there was dry protein sludge obtained that was stable during storage and transportable. In the product dried, the weight fraction of protein was 32.3%, which indicated the feasibility of dry protein sludge to be used and processed as a valuable process and biological feedstock in the production of various foods, including meat products.

In the course of our research, physicochemical indicators of protein sludge were determined in the samples taken at the plant. The data is presented in Table 1.

The study of protein sludge paid special attention to its full-value characterized by its amino acid composition. The amino acid composition and amino acid score of proteins in dry protein sludge are presented in Table 2.

The greatest amount of essential amino acids is accounted for isoleucine and leucine, phenylalanine and tyrosine. Being a waste in the brewing industry, protein sludge contains all the essential amino acids. All proteins of plant origin are known to be basically imperfect, but they are essential to human nutrition. Optimal combination of them with proteins of animal origin, specifically muscle proteins that are complete in nature, provided a product that satisfied the daily need in all essential amino acids. Thus, when developing a sausage recipe, this ratio was taken into account, since besides the economic benefit, it is important to preserve the biological value of the finished product.

When choosing food raw materials and developing the technology of meat products, great importance is attached to microbiological safety indicators that are the main criteria for food products along with the nutritional and biological values. The results of microbiological studies are presented in Table 3.

According to the beer production technology, before getting the protein sludge, hopped wort was subjected to temperature exposure that eliminated the possibility of pathogenic bacteria. The table shows that pathogenic and conditionally pathogenic microorganisms were absent in the protein sludge developed.

In order to determine the optimal amount of protein sludge to be added, four variants of model filling with different replacements of raw meat were developed: 10%, 15%, 20% and 25%. As an object for research, semi-smoked sausages had been chosen because of their popularity among many groups of the population, as they have special aromatic characteristics and are especially nutritious. Their quantity was determined taking into account future economic benefits obtained from the replacement of raw materials of animal origin with raw materials of plant origin and the biological value of the finished product. Organoleptic evaluation of four samples of filling with added protein sludge was carried out. The results are shown in Table 4.

The increasing amount of the herbal supplements in filling caused its color to became lighter and the bitterness and smell of barley to enhance. The conducted organoleptic estimation indicated the appropriate amount of protein sludge added was 15% by weight of raw meat. Sludge has high nutritional value, but has

bitter taste. So, sweeteners are necessary to be used. In this regard, the "Glimalask" food additive was chosen that contains aminoacetic acid (glycine) 80%, ascorbic acid 12% and malic acid 8% [13].

It is a powerful regulator of the body's defense, improves energy metabolism, activates the immune system and promotes the elimination of toxic substances. In this technology, it was used as a color stabilizer, sweetener and preservative. Test and Control batches of semi-smoked sausage were produced; their recipes consisted of raw meat, nitrite-curing mixture, sugar, hydrated sludge and food additive "Glimalask" (Table 5). It was established that in physical and chemical parameters, the developed sausages were not inferior to the control product produced according to GOST 31785-2012 (Figure 1).

The Figure (Fig. 1) summarizes the data on the content of protein, fat and amino acid score of the samples of semi-smoked sausage. In the Test sample containing protein sludge, the protein content was higher by 2.2% and the fat content less by 0.9%.

According to the results of the study of amino acid profiles, it was noted that the limiting amino acids were lysine (87%) and valine (90%). Additionally, the content of glycine as a substance that due to its enhanced presence in the product increases the performance of the brain and allows reducing the impact of toxic substances on the brain was determined. The glycine content in the prototype was 3.2% and in the control 1.4%.

Table 1 – Physical and chemical indicators of protein sludge

Indicators	Content,%
Weight fraction of moisture	85.2±0.6
Weight fraction of dry matter	14.8±0.3
incl. fats	0.4±0.02
ash	2.7±0.01
In the product dried	
Weight fraction of protein, %	42.3±0.6

Table 2 – Amino acid composition and amino acid score of protein sludge

Essential Amino Acid	Perfect Protein		Dry Protein Sludge	
	Amino acid content, g/100g	Amino acid score, %	Amino acid content, g/100g	Amino acid score %
Valine	5.0	100	4.44±0.04	89
Isoleucine	11	100	10.42±0.03	95
Leucine				
Lysine	5.5	100	2.79±0.03	50
Methionine + Cystine	3.5	100	2.15±0.02	61
Tryptophan	1.0	100	0.46±0.03	46
Threonine	4.0	100	2.26±0.04	57
Phenylalanine + Tyrosine	6.0	100	6.47±0.04	108

Table 3 – Microbiological indicators of protein sludge

Indicator	Value	
	Standard	Actual
Enterococcus, CFU/g, not more than	not allowed	not detected
S.aureus, CFU/g, not more than	not allowed	not detected
Coliform bacterias	not allowed	not detected
Yeast and mold, CFU/g, not more than	$1 \cdot 10^1$	0
Total viable count, CFU/g, not more than	$1 \cdot 10^2$	0

ISSN: 0975-8585

Table 4 – Organoleptic estimation of model filling heat-treated

Indicator	Amount of protein sludge added, %			
	10	15	20	25
Taste	moderately salty, no bitterness	moderately salty, no bitterness	moderately salty, light bitterness	harsh bitterness
Colour	dark red	red	light red	pale red
Smell	mild barley	mild barley	pronounced barley	strong barley
Consistency	homogeneous, dense	homogeneous, dense	homogeneous, open	homogeneous, open

Table 5 – Recipes of sausage samples

Ingredient	Sample	
	Test	Control
Beef trimmed 1st grade	39	40
Pork trimmed semi-fat	41.5	46.6
Nitrite salt	2.8	2.8
Sugar granulated	0.2	0.2
Fresh garlic chopped	0.25	0.25
Black pepper ground	0.15	0.15
Dried coriander ground	0.05	0.05
Protein sludge	5	-
Water to hydrate dry protein sludge	10	-
"Glimalask" food additive	0.14	-
Water / ice	-	10

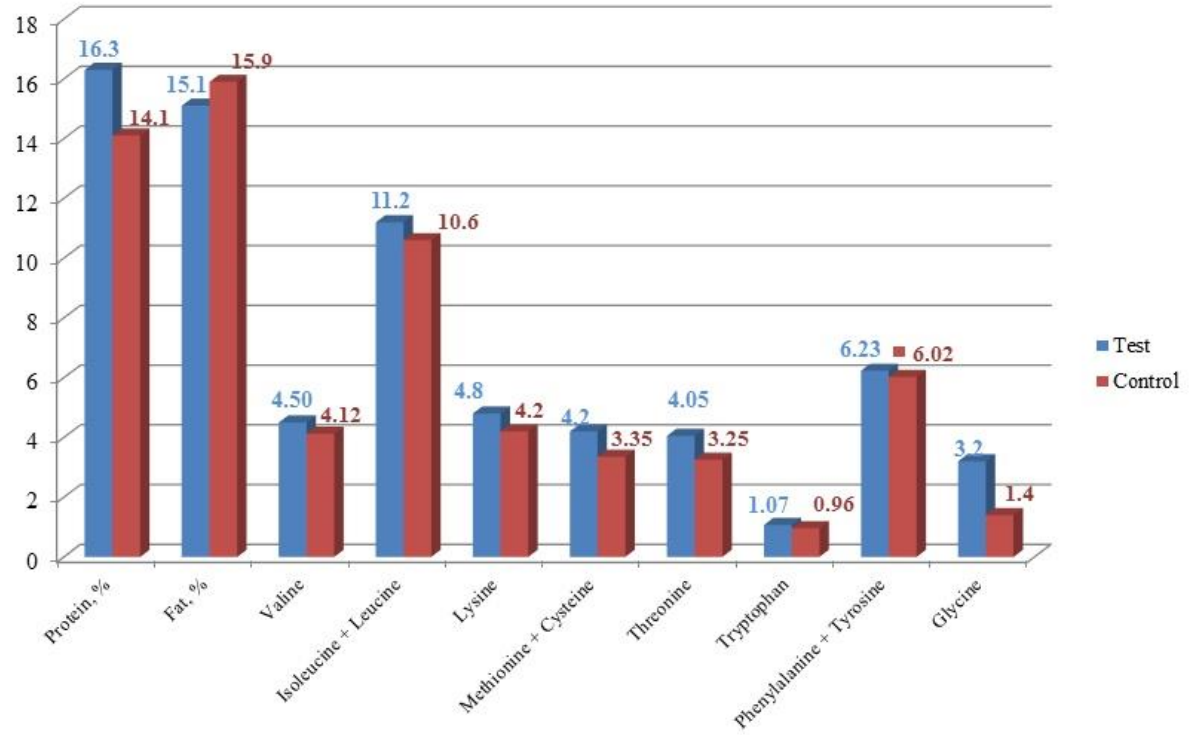

Fig. 1 – Physical and chemical indicators of samples of semi-smoked sausage

It should be noted that the added herbal supplements contributed to the preservation of the usual consumer characteristics of sausage products and formation of a more pronounced taste and flavor.

CONCLUSION

The study research of the quality indicators of sausage products with protein sludge showed that this raw material met all safety requirements, so, its use in the production of meat products is appropriate. Thus, the introduction of pre-hydrated protein sludge contributed to an increase in protein content by 2.2%, as well as optimization of the amino acid profile. Combining protein sludge and the food additive “Glimalask” not only reduced the bitter taste, but also contributed to improved color formation, as well as increased stability during storage, as the organic acids that make up the composition had a bacteriostatic effect. The study of the chemical composition indicated protein sludge as a high-protein product that contains all the essential amino acids. The use of this beer waste will contribute to an increase in the range of wholesome and high-quality meat products, reduce the cost of the finished product and give additional income to breweries.

ACKNOWLEDGMENTS

The work was supported by the Russian Foundation for Basic Research, project no. 15-16-10000, SSI NIIMMP “Development and scientific substantiation of new approaches to the production of livestock raw materials and increasing the biological value of socially important products based on modern biotechnological and molecular genetic methods”. Grant sponsors were not directly involved in the development, analysis, or writing of this article.

REFERENCES

[1] Filonov A.V., Krampit M. A., V. O. Romanenko The current state and promising areas of secondary material resources of the food industry. Fundamental research. 2017. 5, 215–219.

[2] Murzagalieva D.V., Grigoryan L.F., Karpenko E.V. Perspective and evaluation of protein sludge used in the meat products production. Agrarian and food innovations. 2018. 1, 71-75.

[3] Gorlov I.F., Fedotova G.V., Sazonov S.P., Sergeev V.N. and Yuldashbaev Yu.A. Cognitive approach to the study of food security problems: a monograph. Publishing house of Volgograd Institute of Management, branch RANEPA, 2018; 168.

[4] Balashov O.Yu., Utolin V.V. Luzgin N.E Features of obtaining compressed feed from brewing by-products. Agrarian Bulletin of the Upper Volga. 2018. 1, 50-54.

[5] Postnikov A.E., Pavlov I.N. Secondary raw materials used in the brewing industry. Technologies and equipment for chemical, biotechnological and food industries. 2013. 2, 493-496.

[6] Rudenko E.Yu. Current trends in the processing of major brewing by-products. Beer and drinks. 2007. 2, 34-36.

[7] Volotka F.B., V.D. Bogdanov Processing and chemical characteristics of beer spent grain. Vestnik TSEU. 2013. 1., 114–124.

[8] Aliyu S. and Bala, M. Brewer's spent grain: a review of its potentials and applications. African Journal of Biotechnology. 2011. 3, 324-331.

[9] Simones M, Martins Rui F., Marme M. Failure analysis of a filling valve from a Brewery`s beer filler. Engineering Failure Analysis. 2018. Vol. 93, 87-99.

[10] Guillermo G., Woolley G., Rahimifard S. Colwill J, White R. and Needham L. A Methodology for Sustainable Management of Food Waste. Waste Biomass Valor. 2017. 8, 2209-2227.

[11] Jayant M., Hassan M.A., Srivastava P.P., Meena D.K., Kumar P. a , Kumar A. b, Wagde M.S. Brewer’s spent grains (BSGs) as feedstuff for striped catfish. Journal of Cleaner Production. 2018. 199, 716-722.

[12] Russ W. und Meyer-Pittroff, R. The use of phenolic protein precipitates (trub) from beer production in animal feed. Monatsschrift fur Brauwissenschaft. 2003. 56, 84-88.

[13] Food supplement: Pat. 2519777, Russian Federation: IPC A23L1 / 30; A23L1 / 305; A23L1 / 06 / I. F. Gorlov and V.A. Polyakov; Applicant and patentee is State Scientific Institution Volga region research institute of manufacture and processing of meat-and-milk production of the Russian Academy of Agricultural Sciences, OOO Innovation and Research Center "New Biotechnology" No. 2012134605/13; appl. August 13, 2012; publ. 06/20/2014 Bull. No. 17.