Development of combined feed technology based on secondary raw material resources

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Abstract: *Technological, technical and strategic solutions for the processing of feed with the use of substandard raw materials together with secondary raw materials of food production (waste of grain processing, flour-grinding, brewing industries, etc.) are presented: processing of compound feed with polysteam lactic acid sourdough based on whole-ground flour from waste processing of legumes.*
Keywords*: COMBINED FODDER, UNCONDITIONAL GRAIN, PRODUCTION WASTE, POLYSTAMM SOURDOUGH OF LACTIC ACID BACTERIA*

1. Introduction

At the modern level of developed industry in the production of compound feeds great importance is attached to saving material resources, reducing their cost, and producing high quality compound feed. In Kazakhstan, in the production of compound feeds there is a problem of providing compound feed enterprises in sufficient quantities with high-quality raw materials, which make it possible to produce a variety of compound feeds balanced in nutrients in accordance with the physiological needs of farm animals and birds. Many branches of the food industry, when processing agricultural raw materials, generate waste, most of which are secondary raw materials [1].

Of all the variety of raw materials used in industrial technological processes [2-4], plant raw materials are currently a promising renewable resource that can be used as a substrate for growing microorganisms and producing sourdough. At the same time, not only agricultural crops can be used for bioconversion, but also plant wastes (husks, husks, bran), as well as by-products of the processing of agricultural raw materials (distillery stillage, molasses, refined syrup, oilcakes, waste from starch and sugar factories). In this case, it is possible to dispose of waste that pollutes the environment.

Renewable plant materials are of great interest for industrial biotechnology in feed production [5].

In the north of Kazakhstan, the main sources of renewable raw materials are cultivated grain crops. Being the largest grain state, Kazakhstan sows large areas of hectares with grain crops, of which 70% is allocated for wheat. In the southern regions of Kazakhstan, sunflowers, corn, soybeans, rapeseed, rice, sugar beets, many vegetables and fruits are grown. Kazakhstan has huge resources of plant raw materials, which especially contributes to the development of biotechnology. Due to the extreme prevalence and replenishment, vegetable carbohydrates can serve as excellent raw materials for a number of industries, including microbiological ones [6].

Since the northern region of Kazakhstan is located in the zone of risky farming, with the existing organization of agriculture, the harvest is 80% dependent on weather conditions [1]. The shortage of food resources, associated with significant fluctuations in the qualitative and quantitative indicators of the produced grain, leads to the need to accept and process grain that does not meet quality standards.

At the same time, the experience of grain processing enterprises testifies to a relatively low level of use of substandard wheat grain, other cereals and legumes for food purposes. It should be noted that the traditional approach to the processing of grain supplied to the enterprise consists in preliminary bringing its quality to the requirements of regulatory documents, followed by its direction for processing. However, bringing the quality of grain to meet the requirements of standards is not always technologically efficient and economically feasible, therefore, a significant part of substandard grain is directed to feed and technical purposes.

2. Results and discussion

The variety of types of plant raw materials that can be used for the production of combined feed dictates the need for a differentiated approach to solving the problem of its bioconversion, based on the chemical and physical properties of the raw material, its localization and economic prerequisites.

In connection with the current situation, the expansion of the fodder base, in particular, the use of non-traditional energy and protein sources, i.e. increasing the nutritional value of low-value feed raw materials and plant waste of various types, including substandard grain as a non-scarce waste of field cultivation.

Agricultural raw materials were selected for research, in particular substandard wheat grain and soybean waste. This choice is justified by the utilization of agricultural waste and the actual problems of feed protein in Kazakhstan.

Soybean crops in our country are small, but they are constantly expanding. Soybeans rank first in the world economy among legumes [7].

There are three main ways of processing low-value plant materials: physical, chemical and biological [8-10]. The latter method opens up unlimited possibilities for feed production.

In this way, a carbohydrate-protein feed is obtained based on low-value plant materials, which has the most important thing - high nutritional value [11]. In search of a more independent and cheaper way of obtaining carbohydrate-protein feed from substandard grain, it was proposed to use a specially developed starter sourdough based on soy flour and meal instead of enzyme preparations. Substandard grain is processed in a biological, that is, in a natural way with the help of special microorganisms contained in the leaven, a small amount of which is sufficient for processing a large amount of substandard grain. At the same time, the nutritional value of the grain is more than doubled. So 1 kilogram of unconventional grain treated with sourdough can be compared in nutritional value with 2 kilograms of food grain.

Substandard grain is a material that has a high carbohydrate content of 70% and a low protein content of 10-15%. In addition, pure grain is poorly eaten by livestock and has a relatively low digestibility of nutrients (Table 1).

Table 1: *Chemical composition, digestibility and nutritional value of substandard grain*

Indicators	Feed wheat
	Content, %
1	2
Dry matter	85,2
Protein	12,3
Fat	2,3
Fiber	4,4
Sugar	1,5
Cinder	2,4
	Energy value
Feed units / kg	1,16
MJ / kg	11,4
	Content in 1 kg

Digestible protein, g	108,0
Amino acids, g	
lysine	3,9
methionine + cystine	4,1
tryptophan	1,8
Macronutrients, g:	
1	2
calcium	1,9
phosphorus	3,0
sodium	0,1
Microelements, mg	
copper	3,2
iron	41,0
iodine	0,2

Because of poor degradability of fiber in the gastrointestinal tract and the low content of nutrients, animals are not able to consume large quantities of substandard grain. Diets saturated with substandard grains do not provide high animal productivity. The development of environmentally friendly biotechnological processes for the conversion of this type of raw material contributes to the production of valuable targeted feed [12].

For the effective destruction of the carbohydrate complex of substandard grain, a starter sourdough based on soy flour and soybean meal was used. The starter sourdough was prepared at a pH of 5.1-5.2 with the addition of a 0.5% lactose solution to activate lactic acid bacteria capable of destroying lactose. To a substrate consisting of 1 part of grinding (0.6 part of soy flour and 0.4 part of soybean meal) and 2 parts of water heated to a temperature of 90-100^{0}C, a microbiological preparation was added at the rate of 0.1 g per 1 kg of substrate and 0,5% lactose solution at the rate of 100 g per 1 kg of substrate. The starter obtained in this way was left to ripen for 6 hours, and without lactose for 12 hours at room temperature. The seed obtained in this way was used when sowing substandard grain. For this, shredded wheat was placed in a 3000 ml chamber, moistened to a moisture content of 60%, and seed was added. Fermentation was carried out for 3 days (72 h) under anaerobic conditions at a temperature of 25^{0}C with an initial pH of 5.1-5.2. After 36 hours at the end of the exponential phase of growth of microorganisms to activate the biosynthesis of enzymes, 0.5% lactose solution was added discretely to the substrate (at the rate of 100 g per 1 kg of raw material). The efficiency of destruction of the wheat complex was assessed by the accumulation of reducing substances in the fermentolysate (Table 2).

Table 2: *Efficiency of the biodegradation process of substandard grain for the accumulation of reducing substances*

Microbiological processing conditions	The content of reducing substances,%					
	time of microbiological treatment, h					
	12	24	36	48	60	72
Without adding lactose solution	2,09± 0,10	3,10± 0,06	4,03± 0,08	5,60± 0,20	7,19± 0,11	8,4± 0,08
With the addition of lactose solution after 36 hours of fermentation	2,09± 0,10	3,10± 0,06	5,03± 0,06	6,40± 0,09	9,10± 0,01	9,40± 0,09

After 72 hours of fermentation, 51% of the grain fiber was destroyed. The crude protein content was 12.8%, which is 4% more than in the native form of wheat grain. The content of reducing substances with the addition of lactose solution is 23.3% higher than without the addition of this component.

Thus, the treatment of substandard grain (wheat) with sourdough based on soy flour and meal reduces the fiber content by an average of 51%, increases the crude protein by 4%. Biodegradation of substandard grain is effective when a 0.5% lactose solution is added. The content of reducing substances in the product is 23.3% higher. The technical result of the research is to obtain a feed product rich in biologically active prebiotic, probiotic components.

The experimental data obtained determine the main directions of processing substandard wheat grain with microbiological starter sourdough based on soy flour and meal to obtain sugared bulky feed for further use as a feed product in animal husbandry.

The results of the study served as the basis for the development of a technological scheme for obtaining a feed product using a starter sourdough based on soy flour and meal (Fig. 1).

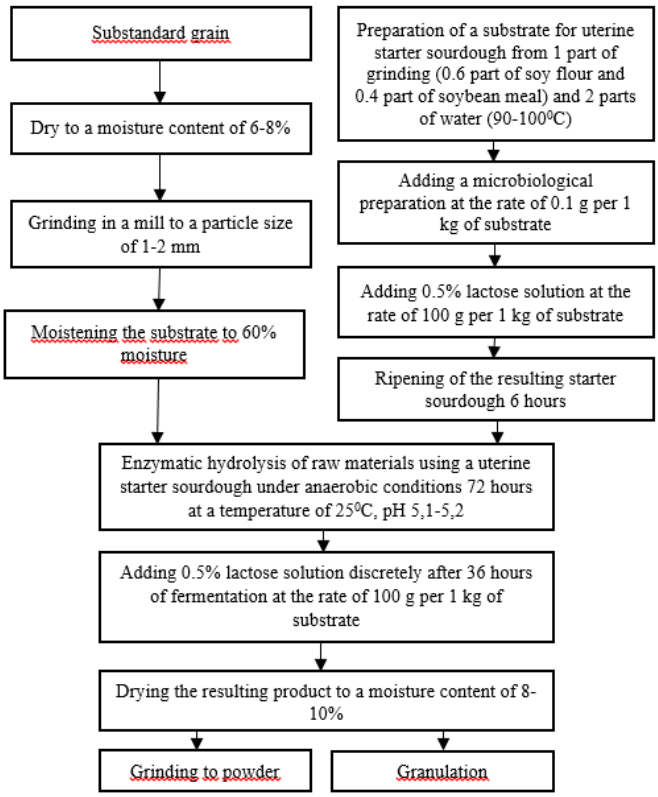

Fig. 1 *Process flow diagram of a feed product by processing substandard grain using a starter sourdough based on soy flour and meal*

3. Conclusion

The analysis of the literature showed that failure to comply with the conditions for harvesting and storing grain leads to an increase in the fiber content in cereals, a sharp decrease in their sugar content.

Protein deficiency is also a key issue for dairy farming.

The studies substantiated the possibility of using substandard grain as a raw material for obtaining feed of increased nutritional value and utilizing soybean processing waste in the leaven used in the technological cycle.

An important task was the search for active strains of microorganisms capable of processing cellulose, which is highly resistant to degradation by microflora.

The maximum yield of reducing substances was the main indicator of the efficiency of the process of destruction of wheat grain. Under the indicated conditions, the maximum protein content in fermentolysates was noted. Deep bio-fermentation was carried out at a mode: pH 5.2 and an ambient temperature of 25°C, which made it possible to consider these parameters as optimal.

It has been established that when processing a sourdough based on soy flour and meal of substandard wheat grain, it is possible to obtain protein-carbohydrate feed products for animal husbandry with a crude protein content of up to 12.8%. The starter used reduces the fiber content in substandard grains by an average of 51% and increases crude protein by 4%.

The targeted use of microorganisms contributes to the production of feed of stable quality. The technological effect of microorganisms is associated with the formation of specific biologically active components: organic acids, bacteriocins,

enzymes, vitamins, etc., which helps to improve the sanitary-microbiological, organoleptic characteristics of the finished product.

Enzymes such as protease, amylase, cellulase and their combinations hydrolyze proteins, starch, fiber and promote their better assimilation by the animal body, strengthen and normalize the digestion processes.

Thus, using microorganisms as producers of enzymes and fodder protein, the research tasks were solved – the production of protein mass and the utilization of crop waste, which can be sources of environmental pollution.

4. References

1 Kolomeichenko, V.V. Modern reserves for increasing feed production / V.V. Kolomeichenko // Bulletin of OrelGAU. - 2007. - No. 1 (4). - S. 32 - 38 /

2 Kadnikova, Olga; Altynbayeva, Gulnara; Aidarkhanov, Arman; et al. Potential analysis of implementation of developed technology for processing of sewing and knitting fabrics: International Scientific / Environmental and Climate Technologies. Riga, LATVIA Energy Procedia. - 2017. - T. 128, S. 411-417.

3 Kadnikova, O., Altynbayeva, G., Kuzmin, S., Toretayev, M., Khabdullina, Z. Ecological Feasibility of Applying Technology in Recycling Garment and Knitwear Production / Environmental and Climate Technologies, 2019, 23 (2), pp. 291-309

4 Kadnikova, O., Altynbayeva, G., Kuzmin, S., Aidarkhanov, A., Shaldykova, B. Recycling of production waste as a way to improve environmental conditions / Energy Procedia, 2018, 147, pp. 402–408

5 Gorelikova, G.A. Fundamentals of modern food biotechnology: Textbook / G.A. Gorelikova. - Kemerovo: Kemerovo Technological Institute of Food Industry, 2004. - 100 p.

6 Ezdakov, N.V. Application of enzyme preparations in feed production / N.V. Ezdakov, V.V. Sherstobitov, A.P. Levitsky [et al.] // Prospects for the use of industrial enzyme preparations in the feed industry. - Kiev: Exercise. on press, 1991. - S. 41 - 48.

7 Smirnova, V.D. Waste from the production of concentrated protein products from soybeans as raw materials for the production of feed additives: author. dis. Cand. tech. Sciences: 03.01.06 / V.D. Smirnova; Russian University of Chemical Technology named after D.I. Mendeleev. - M., 2012. - 19 p.

8 Alimova, F.K. Biotechnology. Industrial application of fungi of the genus Trichoderma / F.K. Alimova, D.I. Tazetdinova, R.I. Tukhbatova // Study guide. - Kazan: UNIPRESS DAS, 2007. - 234 p.

9 Alimova, F.K. The use of Trichoderma in the processing of alcohol production waste / F.K. Alimova, E.V. Skvortsov, T.A. Melnikova [et al.] // Bulletin of biotechnology. - 2007. - No. 3. - P. 22 - 26.

10 Volova, T.G. Introduction to Biotechnology. Version 1.0 [Electronic resource]: electron. study. allowance / T. G. Volova. - Electron. Dan. (2 Mb). - Krasnoyarsk: IPK SFU, 2008. - (Introduction to biotechnology: UMKD № 143-2007 / head of the creative team T. G. Volova). - 1 electron. wholesale disc (DVD). - System. requirements: Intel Pentium (or similar processor from other manufacturers) 1 GHz; 512 MB of RAM; 2 MB of free disk space; DVD drive; operating system Microsoft Windows 2000 SP 4 / XP SP 2 / Vista (32 bit); Adobe Reader 7.0 (or a similar pdf reader).

11 Gneusheva, I.A. Biotechnological approaches for obtaining protein-carbohydrate feed additives for animal husbandry / I.A. Gneusheva, I.V. Gorkova, V.N. Dedkov // Development of the innovative potential of agro-industrial production: Materials of the All-Russian scientific-practical conference on November 24, 2010. - Orel: Publishing house of OrelGAU, 2010. - pp. 45 - 48.

12 Sushkova, V.I. Waste-free conversion of plant raw materials into biologically active substances / V.I. Sushkova, G.I. Vorobieva - M.: DeLi print, 2008. - 216 p.