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EFFICIENCY OF THE INNOVATIVE USE OF WASTE FROM FRUIT AND VEGETABLE PRODUCTION

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Waste recycling is one of the priority directions of resource conservation in the agricultural sector. Modern innovations in the use of waste from fruit-and-vegetable production only partly contribute to resolving the contradictions between the growing needs of the population in high-quality food products and the limited production volumes of agricultural raw materials.

The scientific and practical results of the research are based on the monographic method used at the FG (Farm Enterprise) "Agroinnovatsiia" in Zastavniv district of the Chernivtsi region. The method concerns the innovative technology of preserving apple pomace in closed trenches using a natural sorbent, bentonite, and the replacement of a part of concentrates with the preserved apple pomace in feeding rations of pigs. The processing of empirical data by means of statistical and economic methods allowed substantiation of the reduction in the amount of fodder resources required per 1 hwt of gain by 2.2%, a 5.5% reduction in the cost price, and a profit increase by more than 2 times.

Key words: bentonite, preserved apple pomace, profit, average daily gain of pigs, cost price.
JEL Codes: O33, Q 55, Q 01

1. Introduction

The idea of introducing non-waste technologies into production and the inclusion of waste in the production processes of agro-industrial enterprises as secondary raw materials is currently in the focus of attention of effective innovations regarding the use of waste from fruit-and-vegetable production. This makes it possible to convert them into a valuable product with its subsequent widespread use as fodder for the pig breeding. The economic effect of using waste is achieved through increasing the production volumes of the pig breeding industry and reducing a great part of its production costs.

The problems of using waste in the agricultural sector of economy were reflected in the works of Blazh (1990). In particular, the aspect of the problem is to find new organizational and economic principles for the development of agribusiness industries, which takes into account both economic and environmental factor. Currently, it increasingly affects the formation of the technological structure of processing agricultural raw materials.

In this context, it is expedient to refer to the scientific and practical achievements of Levandovskyi (2006). He notes that the testing of the technological process of the secondary use of carbon-containing raw materials into alcohol and baking yeast in more than 15 enterprises. He proves that solving the problem of resource conservation is possible through a combination of two aspects – economic and environmental. The first of them is connected with the expansion of resource possibilities of the fruit-and-vegetable production, with the increase in the efficiency of using primary agricultural raw materials, the second one with the termination of the negative impact of waste products on the environment.

Results of the research by Parobok (2015) indicate that under modern conditions one of the directions for the intensification of fruit-and-vegetable production is the introduction of innovative low-waste and non-waste technologies. This implies not only increasing the degree and completeness of the processing of agricultural raw materials with a more complete extraction of its useful components, but also the inclusion of waste products turnover in the fruit-and-vegetable industry in order to further obtain commodity products made of them. It is also proved that priority resource conservation provides the highest level of material intensity of production.

Problems of transferring the processing of agricultural raw materials into non-waste production cycle are considered by Pysarenko (2008). The researcher points out that owing to a deeper processing of agricultural raw materials and the inclusion of unused waste as a source for obtaining food products, as well as fodder and fertilizer production. The processing of agricultural raw materials is currently one of the most high-waste sectors of the national economy. Only in Ukraine the current output of waste and by-products is about 50 million tons annually. This waste contains hundreds of thousands of tons of sugar, protein, food acids and oils, vitamins and many other valuable substances, which are produced at specialized enterprises. At present, no more than 22% of waste is subject to industrial processing.

At the same time, Tymchak (2016) investigates directions for the use of waste from the brewing industry as fodders for feeding cattle. The subject-matter of the investigation is to carry out an integrated assessment of the use of waste from the food industry in order to ensure the environmental, resource conservation, reproductive nature of the production potential of the industry and reduce the load on the environment.

The need to combine economic, environmental and legal aspects in solving the problem of resource conservation, greening of production at food industry enterprises is investigated by Sheremet (2010).

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Foreign scientists such as Ottman, Tyva, Dali, Okada, Kawasaki, Katta, Targan (2011) focus in their works on the direct correlation between the country's environmental safety and the introduction of innovative technologies in the processing of food waste with the economic benefit for the sectors of a market economy.

Despite the considerable amount of scientific works and publications in the field of waste utilization, the problem regarding the efficiency of innovations in the use of waste products from fruit-and-vegetable production at 2 levels is of the particular scientific and practical interest. The first level is the preservation of apple pomace in closed trenches using natural sorbent, bentonite, which results in the receipt of high-quality fodder resources. The second one is the replacement of part of concentrates with the preserced apple pomace, which allows reducing feed consumption per 1 hwt of pork gain, decreasing cost price and increasing profits.

The hypothesis of the research is the process of increasing the efficiency of using waste from fruit –and-vegetable production, taking into account the results from the introduction of innovative methods and advanced technologies in the production process.

The purpose of the research is to conduct experiments on preserving apple pomace using natural sorbent, bentonite, and the inclusion of preserved waste in daily rations for feeding pigs on feed at the FG (Farm Enterprise) "Agroinnovatsiia" in Zastavniv district of the Chernivtsi region. Another purpose is to prove that the reuse of waste from fruit-and-vegetable production results in reducing feed consumption per 1 hwt of pork gain, decreasing cost price and increasing profits.

The object of the research is the processes of ensuring the efficiency of innovations regarding the use of waste products from fruit-and-vegetable production through the example of FG (Farm Enterprise) "Agroinnovatsiia" in Zastavniv district of the Chernivtsi region.

The subject of the study is a set of applied aspects for assessing the efficiency of innovative activities at enterprises of the agricultural sector of economy with regard to the use of waste from fruit-and-vegetable production based on calculations per 1 hwt of pork gain: feed consumption, cost price, profit and profitability.

Research into the efficiency of innovations with regard to preserving apple pomace and their use for feeding pigs on feed was carried out at FG (Farm Enterprise) "Agroinnovatsiia" in Zastavniv district of the Chernivtsi region during 2016-2018.

The research methodology is based on the following methods: monographic (in the study of the current state of the implementation of innovative technologies of the use of waste from fruit-and-vegetable production at FG (Farm Enterprise) "Agroinnovatsiia" in the Chernivtsi region; economic and statistical (for the assessment of the efficiency of the use of an innovative feed type for feeding pigs on feed in farming); and tabular (for presenting analytical information).

The most significant results of the research include the assessment of the efficiency of the use of waste from fruit-and-vegetable production on the basis of the author's invention (the innovative type of feed, preserved apple pomace), and also the efficiency of introducing this type of feed in the process of feeding pigs on feed, which

allows achieving an increase in the production volume of livestock products (gain of body weight of pigs) while minimizing their production costs.

2. Results

Intensive development of fruit-and-vegetable production is aimed at the efficient use of agricultural raw materials, which is an important source for increasing food production and raising the level of their economic accessibility for the population. One of the priority directions of resource conservation (in the agricultural sector of economy) in the world economy is the secondary use of waste from the fruit-and-vegetable industry.

Scientists consider the use of waste as a reserve for improving production efficiency. In particular, the efficient use of agricultural raw materials is an important source for increasing food production and raising the level of their economic accessibility for the population in the fruit-and-vegetable industry, which is currently developing intensively. However, the priorities of the secondary use of waste products from fruit-and-vegetable production are determined by the introduction of innovative technological processes of their reuse not only in single-sector structures (baking, brewing, juice, etc.), but also in the agricultural sector as a whole, when the use of waste from one industry is used as raw materials in another one. Currently, there is a lack of unified approaches to coordinating integrated resource conservation in the agricultural production system.

The use of waste products in the production process allows for converting them into valuable, sometimes even hard-to-find raw materials used in agriculture more often as fodders for livestock and fertilizers in crop production, in other industries and for recycling at the same enterprise where they are obtained (Kageyama, 2007; Farré, 2011).

There are more than 90 countries in the world which produce apples. Ukraine, for which apples are the main product of gardening, is 12th in this rating, with a total production of 3.3 million tons, half of which goes to the processing of juices. As a result of industrial processing it is possible to obtain 200-350 l of juice of 1 ton of apples and 650-800 kg of waste is produced. In 2011-2017, about 1 million tons of apple pomace was annually produced in Ukraine (Chaploutskyi, 2017).

The latest technologies borrowed from the advanced gardening countries of Europe, investments and state financial support in combination with fertile land, favourable weather and climate conditions, gave a boost to the development of horticulture in Bukovyna, making it promising and profitable (Colman, 1975; Lonergan, 1979; Sheremet, 2010). Thus, for 1.3% of the state's land about 8% of the gardens of Ukraine are concentrated in Bukovyna. In particular, 30 thousand hectares of land are occupied by gardens in Chernivtsi region and 28 enterprises engaged in the processing of fruit-and vegetable-products operate there. It should be noted that the reuse of apple pomace as a secondary raw material is not present at any enterprise. Waste of fruit-and-vegetable enterprises create unauthorized dumps, which lead to

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pollution of groundwater and land plots and negatively affect landscape and biological diversity.

Fresh apple pomace is characterized by high humidity (24-28 solids), it is not stable when stored and because of high content of grains it quickly accumulates mycotoxins (Pérez-Massot, 2013; Skliankin, 1988). At the same time, it is enriched with nutritious and biologically active substances which are equated with high quality corn silage by content and can serve as an additional source of supplement for the ration of animal nutrition with nitrogen-free extractable substances, essential amino acids, mineral elements and vitamins.

A unique innovative technology for the preservation of apple pomace in closed trenches using a natural sorbent bentonite of the Neporotovo deposit is a promising direction that allows the use of waste from the fruit-and-vegetable production. This technology was developed in FG (Farm Enterprise) "Agroinnovatsiia" and it is unparalleled in Ukraine.

The preservation of residues from fruit-and-vegetable production is based on the creation of special anaerobic conditions based on the sealing of the hopper (trench), where the air content should not exceed approximately 0.2% (in terms of volume) and the bentonite content is not less than 2.5 kg per cubic metre of weight (Huber, 2010; Barber, 1966; Buiatti, 2013). Under these conditions, most fungal organisms, which cause perishing of fresh apple pomace, are inactivated (insects die in case of 2% oxygen content). The creation of oxygen-free conditions is achieved by plugging and sealing after filling the trench. The bentonite absorbs not only mycotoxins, but also toxic technogenic substances (pesticides, dioxins, ammonia, etc.). In addition, the bentonite includes calcium, sodium, sulfur, iron, copper, zinc, manganese, that is, those mineral elements that need to be additionally introduced into the animal ration.

A month after the laying of a mass of fresh apple pomace for preservation, it was established that the moisture content of preserved pomace is 72%, ph is 4.95 and mycotoxins are absent.

The proposed innovative technology for the preservation of apple pomace allows an increase in the duration of its use from 5 days to 6 months without using special chemicals and it also contributes to the receipt of high-quality fodders and the increase in the production of livestock products. In addition, the non-waste technology for the preservation of apple pomace ensures the ecological condition of the surrounding areas of the enterprises of the fruit-and-vegetable industry.

The use of waste from fruit-and-vegetable enterprises can be carried out at 2 levels: the first, directly by enterprises of the fruit-and-vegetable industry (as secondary raw materials for the production of commodity output), and the second, in agricultural organizations as fodder resources in livestock production.

In regards to productive effect, preserved fruit pomace is considered equivalent to silage prepared from grasses. When they are used in animal feeding rations it possible to minimize the costs of using expensive concentrated fodders. The use of fruit pomace is a reserve of resource conservation in the livestock industry. This ensures saving of material resources in the production of livestock products, reduces its cost,

increases the productivity of animals, and ultimately improves the efficiency of the functioning of enterprises in the agro-industrial complex.

To identify cause-effect relationship between the use of fruit pomace and the increase in the productivity of animals, a scientific and economic experiment was carried out at the FG (Farm Enterprise) "Agroinnovatsiia" of the Zastavna raion in Chernivtsi region.

60 three-month-old store pigs were selected for the experiment, of which three experimental groups with 20 animals in each were formed by the method of pair-analogues. Thus, the first group was a control one, and the second one and the third one were experimental. The animals of the control group received traditional feeding rations, developed by the technologists of the FG (Farm Enterprise) "Agroinnovatsiia", which were congruent with the general feeding patterns with the planned average daily gain in the body weight of store pigs by 700-800 g. The pigs in the second experimental group received fodders where 10% of concentrated fodder was replaced with preserved apple pomace; for pigs of the third experimental group 20% of concentrated fodder was replaced with preserved apple pomace. In regards to the chemical composition, the three types of ration met the agreed standards that must be observed while feeding pigs.

The analysis of the obtained results shows that the introduction of pomace (i.e. replacement of 10% and 20% concentrated fodders) to the ration of pigs of the 2nd and 3rd experimental groups contributed to the difference in gain of live weight compared to the control group. The absolute increase in the body weight of pigs per head in the second experimental group increased by 1.2 kg in comparison with the control group, and in third group it was lower by 0.3 kg. That is, the highest growth intensity was observed among pigs of the 2nd experimental group, where 10% of concentrated fodder was substituted by the preserved apple pomace (Table 1).

Table 1. Efficiency of using preserved apple pomace while growing store pigs according to the results of experiment

Indicators	First control group of animals (with traditional daily ration for feeding pigs)	Second experimental group of animals (with addition of 150 g of preserved apple pomace to the daily ration)	Third experimental group of animals (with addition of 300 g of preserved apple pomace to the daily ration)
Stock of store pigs, heads	20	20	20
Preparation period of the experiment, days	20	20	20
Experimental period, days	98	98	98
Weight of animals at the beginning of experimental period, kg	34.4	34.5	34.2
Weight of animals at the end of experimental period, kg	112.2	114.0	111.8

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Average daily gain during experimental period, g	794	811	792
Fodder required per 1 hwt of gain, hwt of fodder units	3.19	3.12	3.20
Feed consumption per 1 head, hwt of fodder units	2.48	2.48	2.48
Digestible protein consumption per 1 head: total kg	26.04	25.96	25.88
Digestible protein consumption per 1 hwt of gain, kg	33.40	32.65	33.35

Compared with the control group, in the first group, 10% of concentrated fodder was replaced with pomace, in the second group it was 20%. The replacement with pomace did not cause a probable difference by the nutrient value of concentrated fodders (P 0.95) in gain in animals of the first and second groups. However, the production cost of gain was reduced due to a significantly lower cost of 1 fodder unit of pomace compared to 1 fodder unit of concentrated fodders (or according to European standards, 1 MJ forage energy).

Thus, the average daily gain of the body weight of one animal in the control group amounted to 794 g during the experimental period, while in the experimental groups it was 811 g and 792 g, respectively. On average, during the experiment pigs of control and experimental groups received 2.48 hwt of fodder units per head. In order to achieve 1 hwt of pork gain, 3.19 hwt of fodder units were used for the control group, while for the 2nd experimental group it was by 0.07 hwt less and for the 3rd group by 0.01 hwt more.

This data indicates that the replacement of 10% of concentrated fodders with the preserved apple pomace in the second experimental group and 20% in the third group provide a gain in live weight of animals at a lower consumption of fodder resources.

In order to establish the economic expediency of replacing a part of concentrated fodders with the preserved apple pomace, the economic efficiency of the suggested innovative fodder type obtained as a result of the author's technology was calculated (Table 2).

Thus, due to replacing a part of concentrates with the preserved apple pomace, the production cost of the ration decreased compared with the control group, for the animals of 2nd experimental group by € 0,07 thousand and for 3rd group by € 1,32 thousand. As a result, the production cost of 1 hwt gain of pigs on feed decreased compared to the control group, in 2nd group by 4.3% and in 3rd group by 5.5%. The amount of profit in regards to animals of the 2nd and 3rd experimental groups was € 233 and 252,6 respectively, while the level of profitability increased from 5.28% (in the control group of pigs) to 10.28 in 2nd experimental group and 11.33% in 3rd experimental group due to the introduction of apple pomace.

Table 2 Economic efficiency of using preserved apple pomace for feeding pigs on feed

Indicators	First control group of animals (with traditional daily ration for feeding pigs)	Second experimental group of animals (with addition of 150 g of preserved apple pomace to the daily ration)	Third experimental group of animals (with addition of 300 g of preserved apple pomace to the daily ration)
Obtained gain, total hwt	15.56	15.90	15.52
Average daily gain, g	794	811	792
Production cost of the ration, total € thousand	53.82	51.83	49.85
Production cost of the obtained gain, total € thousand	70.94	69.32	66.92
Production cost of 1 hwt of gain, €	4559	4360	4310
Selling price of 1 hwt of gain, €	4800	4800	4800
Total value of gain, € thousand	74.69	76.32	74.50
Profit, €	3.75	7.00	7.58
Level of profitability, %	5.28	10.10	11.33

The practical use of preserved apple pomace showed that their use allows for the reduction in the production cost of the ration and the increase in the level of profitability of pig breeding without detriment to daily average gain.

The investigation conducted at FG (Farm Enterprise) "Agroinnovatsiia" indicates that the productivity of pigs on feed in the 2nd control group is 811 g, which is by 0.09 g less, compared to the average daily gains in the EU (820 g). The cost price of 1 hwt of gain is € 145, which is by € 191 below the average European indicator.

One of the main indicators of the meat quality is its active acidity – pH. Since the concentration of hydrogen ions in meat depends on the content of glycogen and lactic acid in the muscles at the time of slaughter and, consequently, is a derivative of the physiological state of animals before slaughter, and also reflects the occurrence of post-slaughter processes in the carcass. This index is closely related to colour, moisture content, tenderness and other qualitative indicators of meat. Deviation of the pH of meat in carcasses from the norm leads to economic losses. In addition, it was established that the pH of meat by 50% depends on the conditions of feeding and feed rations.

In the studied samples, there were no significant violations of glycolytic processes in animal meat of control and experimental groups. The active acidity of meat in experimental groups with average daily gains of 700-800 g was within the range of 5.51-5.64 when slaughtered at 125 kg.

The tenderness of meat, which is expressed in the velocity of the cross-section of the area of muscle fibers within a certain time, on average in groups was 9.31-9.68 when slaughtered at 125 kg. The meat of animals from the control group, where

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animals received only the concentrated fodders was slightly more tender, but no significant difference in the indices was established.

One of the important indicators of meat quality is its moisture-retaining ability, which affects the output of finished products and is closely related to the juicy and other culinary properties. Recently, in determining the quality of meat, more attention is paid to the issue of hydration ability of meat (its moisture content).

Watery content in meat is tightly bound to the protein substance ("bound water"), and part of it is mechanically retained due to capillary forces in the ducts formed by strong loosening of the muscular structure ("free water"). "Bound water in meat has a great influence on the quality of the finished meat products. Therefore, the moisture-retaining ability of meat is one of the main indicators of its technological characteristics.

The research data suggests that the indicator of bound water, which expresses the ability of the meat to retain moisture, under the same feeding conditions (average daily gains of 600-800 g), the management and slaughter of experimental animals, the total content of bound water in meat of the experimental groups amounted to 55.32-58.32% – at 125 kg without a clear tendency to change when pomace was introduced.

Therefore, preserved apple pomace is one of the priority fodder types that can provide an increase in high-quality pork at the lowest cost.

In Ukraine, in 2018, the pig stock increased to 7.522 million heads. The stock stabilized in the private sector, its share in the ratio of livestock in households and the industrial sector has been maintained at a level of about 50% for some years. According to the regional distribution, Donetsk, Dnipropetrovsk, Cherkasy, Kyiv and Poltava regions occupy the first place in the number of livestock. Donetsk, Kyiv, Dnipropetrovsk, Poltava and Lviv regions are the leaders in terms of production volumes.

In Ukraine, about 1 million tons of fruit and vegetable waste are produced. If they are preserved and used as fodder instead of, for example, corn silage, we will release 1000000 tons*0.18 f.u.=180000 tons f.u./7=25714 hectares of land. Agroholdings declare that they have an average profit of € 266 per hectare, that is, the economic effect within the state will be (25714*8000) € 6.8 million, in addition taxes, jobs, improvement of ecology, reduction of the production cost of livestock products, etc.

If we consider the production structure of the pig breeding industry, we have the following picture: 148 enterprises keep a stock amounting to 5 thousand or more; 410 enterprises from 1 to 5 thousand heads, and a large number of those that keep from 100 to a thousand heads. 1% is occupied by enterprises with up to 99 pigs. In contrast, there are 20 farms, which now grow more than 20 thousand heads. The undisputed leader is "APK-Invest" (almost 280 thousand pigs), the second position is occupied by "Globyno" (about 150 thousand), followed by "Danosha" (127 thousand), "Agropromyslova Kompaniia" (112 thousand) and the last of the top five leaders "Nyva Pereiaslavshchyny" with more than 100 thousand pigs.

In total, in 2018, 765 thousand tons of pork was produced in Ukraine, which is almost by 30 thousand tons of pork more than last year. 990 thousand tons were consumed, and 234 thousand tons imported.

The pig stock in the EU has remained relatively stable over the past few years; however, profitability of pig breeding industry has been decreasing, says Jim Long, president and chief executive officer of Genesus, according to pigua.info. "One of the indicators of the market problem is the collapse of the prices for pigs on feed, which are now set at 33 euros, which is by 23% less than a year ago. This reflects the fact that the supply is now higher than demand, and it puts financial pressure on two large European pig producers: Denmark and the Netherlands. The price for live weight is also influenced by higher fodder costs. The average price for pigs in the EU is around 1.45 EUR/kg, which could be good for America, but not for most EU producers", Mr. Long said in his Global Market report (In UA, 2018).

It is expected that by the end of the year, against the backdrop of low prices and the growth of tension with exports, rapid growth will slow down, reaching 24 million tons (+1.5% year on year).

According to the report "Stock Analysis – December 2017", following the growth of the breeding stock in the EU (+1.1% against the results of last year), pork production in the EU increased by 4.1% (in tons) in the first quarter of 2018 compared to 2017. At the same time, growth was noted in most of the member countries, especially in Eastern Europe: Poland (+12%), Romania (+18%) and Slovakia (+19%). In 2019, production is expected to stabilize, but this will depend on the state of exports (Pork market, 2018).

The volumes of pork production in the EU increased by 190 thousand tons (+3%) in the second quarter of 2018, compared to the same period last year, reaching a total of 5.8 million tons, according to the data of the Agriculture and Horticulture Development Board (AHDB).

AHDB analysts say it is a result of an increase in pigs slaughter by 3% (1.8 million heads) to 63.4 million heads over the period, and a slight increase (+400 g) of slaughter pig weight to 92.2 kg.

Pork production in the EU increased in the first half of the year by 4%, reaching 12 million tons. The slaughter of pigs amounted to 130 million heads in the specified period, which is by 3% (3.5 million heads) more than a year ago.

The increase in production throughout Europe in the last quarter is determined by an increase in pork production in Spain – 1.1 million tons of pork, which is by 10% (+110 thousand tons) more than in 2017. In addition, a growth in Polish production was observed – at the level of 5% (+26 thousand tons) to 500 thousand tons. Germany accounted for 22% of the total pork production in the EU in the second quarter, but German production slightly decreased by 2% (-30 thousand tons) to 1.3 million tons (EU: Pork production, 2018).

Worldwide production of pork is expected to increase by 1% in 2019, reaching 114.6 million tons on the basis of continued expansion of production in China and the

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United States of America, the US Department of Agriculture (USDA) predicts. World production of pork will reach 114.6 million tons in 2019.

The US Department of Agriculture predicts that increase in global pork production will practically be in line with population growth.

China is expected to show the largest growth in pork production due to larger breeding flock and improved pig productivity. On the other hand, the US Department of Agriculture warns that this increase might have impact on pork prices in the Chinese market. In addition, it cannot but affect the country's industry and the spread of African swine fever (ASF) this year, which has already led to a slowdown in growth compared with last year.

Meanwhile, pork production in the EU is expected to decline, as lowering prices for pigs and higher fodder costs will stimulate a slight decline in the breeding flock.

Global pork exports are also expected to increase by 3% in 2019 on the basis of high demand in the world market. The US Department of Agriculture also noted that the EU is likely to remain the leader in exports of pork, supported by higher demand in Asia, especially in China. The USA occupies the second place in the ranking of the world's leading exporters of pork (The market, 2019; World production, 2019).

With the reduction of pork consumption in the EU, the European Commission expects large volumes to be supplied to world markets in 2019-2030, mainly to China, despite the stiff competition on the part of the United States and Brazil (Europeans, 2018).

In the vast majority of countries, food waste is processed, dried and used as a part of animal fodders in dry form at a feed mill. The authorities stimulate this by means of grants and compensations. How can it be compared with us taking into account that food waste is simply embedded in our country? The most up-to-date and relevant in the research is a way of preserving i.e. using a natural preserving agent. Developed countries are now in search of natural preserving agents that can be used in food products instead of preserving agents obtained by chemical means.

3. Conclusions

An innovative method is suggested for obtaining preserved apple pomace. This method is based on the creation of special anaerobic conditions based on the sealing of the hopper (trench), the air content, where the air content should not exceed approximately 0.2% (in terms of volume) and the bentonite content is not less than 2.5 kg per cubic metre of weight. Under such conditions, most fungal organisms that cause perishing of fresh apple pomace are inactivated. It is noted that the creation of oxygen-free conditions is achieved by plugging and sealing after filling the trench. It is proved that the bentonite absorbs not only mycotoxins, but also toxic technogenic substances (pesticides, dioxins, ammonia, etc.). In addition, the bentonite includes calcium, sodium, sulfur, iron, copper, zinc, manganese, that is, those mineral elements that need to be additionally introduced into the animal ration. The proposed innovative technology for the preservation of apple pomace allows an increase in the duration of

its use from 5 days to 6 months without using special chemicals and it also contributes to the receipt of high-quality fodders and the increase in the production of livestock products. In addition, the developed non-waste technology for the preservation of apple pomace ensures the ecological condition of the surrounding areas of the enterprises of the fruit-and-vegetable industry.

It is proved that the obtained preserved apple pomace is effectively used in feed rations of animals. The analysis of the results of the experiment conducted at the FG (Farm Enterprise) "Agroinnovatsiia" shows that the introduction of preserved apple pomace as a substitute for concentrates in the amount of 10% and 20% of the daily ration for pigs on feed increased the gain of live weight of animals at a lower consumption of fodder resources. Thus, due to replacing a part of concentrates with the preserved apple pomace, the production cost of the ration decreased compared with the control group, for the animals of 2nd experimental group by UAH 2.01 thousand and for 3rd group by UAH 3.97 thousand. As a result, the production cost of 1 hwt gain of pigs on feed decreased compared to the control group, in 2nd group by 4.3% and in 3rd group by 5.5%. The amount of profit in regards to animals of the 2nd and 3rd experimental groups was UAH 7.00 and 7.58 thousand respectively, while the level of profitability increased from 5.28% (in the control group of pigs) to 10.28 in 2nd experimental group and 11.33% in 3rd experimental group due to the introduction of apple pomace.

The scientific and practical results of research into the use of food industry waste allow obtaining significant saving of material and energy resources, and provide an increase in the level of circularity of industrial-resource cycles in the industry, which leads to an increase in the economic efficiency of production, as well as in its volumes and product range. At the same time, the process of pollution of the environment with industrial waste is minimized.

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INOVATYVAUS VAISIŲ IR DARŽOVIŲ ATLIEKŲ GAMYBOS PANAUDOJIMO EFEKTYVUMAS

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Atliekų perdirbimas yra viena iš prioritetinių išteklių panaudojimo žemės ūkio sektoriuje krypčių. Šiuolaikinės vaisių ir daržovių gamybos atliekų naudojimo naujovės tik iš dalies prisideda prie prieštaravimų tarp augančių aukštos kokybės maisto produktų gyventojų poreikių ir riboto žemės ūkio žaliavų gamybos kiekio.

Moksliniai ir praktiniai tyrimo rezultatai grindžiami monografiniu metodu, atlikus tyrimą žemės ūkio bendrovėje „Agroinnovatsiia" Chernivts, Zastavnovo rajone. Šis metodas yra susijęs su naujoviška obuolių išspaudų konservavimo technologija uždarose tranšėjose, naudojant natūralų sorbentą, bentonitą ir dalies koncentratų pakeitimą konservuotomis obuolių išspaudomis kiaulių pašaruose. Empirinių duomenų apdorojimas statistiniais ir ekonominiais metodais leido pagrįsti reikalingų pašarų išteklių kiekio sumažėjimą.

Reikšminiai žodžiai: bentonitas, konservuotos obuolių išspaudos, pelnas, vidutinė paros norma, kiaulių kaina, kaina.

JEL kodai: O33, Q 55, Q 01

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