Agronomy Research **18**(4), 2559–2567, 2020
https://doi.org/10.15159/AR.20.205

Experience and prospects for application of by-products of processing of fruits in the production of animal feed

I.A. Plotnikov[1,2,*], M.M. Mukhamedyanov[1], I.A. Domsky[1], O.Yu. Bespyatykh[3] and N.A. Makarova[4]

[1]Russian Research Institute of Game Management and Fur Farming, 79 Preobrazhenskaya street, RU610000 Kirov, Russia
[2]Vyatka State Agricultural Academy, 133 October Avenue, RU610017 Kirov, Russia
[3]Vyatka State University, 12 Orlovskaya street, RU610002 Kirov, Russia
[4]Kirov State Medical University, 112 Karl Marx street, RU610998 Kirov, Russia
[*]Correspondence: bio.vniioz@mail.ru

Abstract. The purpose of the research was to study the feasibility of using by-products of the industrial processing of fruits for the production of full-feed mixed fodders with the possibility of using these mixed feeds as the only feed in the diets of herbivorous fur animals (nutria, brown muskrat, steppe marmot). Studies of chemical composition and nutrition have shown that non-traditional ingredients can be included in the composition of feed. At their expense, you can save up to 30% of leguminous feed, 9% - cake, 1% - meat and bone meal. This allowed us to reduce the cost of the studied batches of feed by 18–21%. Experiments have shown the effectiveness of using such feed in the diets of herbivorous fur-bearing animals. The inclusion of compound feed in the diet allowed to increase the number of commercial offspring per female muskrat by 0.8 heads, compared to the control group. The safety of young animals until the moment of depositing puppies from their mothers was approximately equal in both groups. Young muskrats of the experimental groups had 5.5–6.8% higher values of average daily increments, compared to control analogues. A similar pattern is established in male nutria. Marmots of the experimental group from the very beginning of the experiment were outnumbered by control animals. In July, these differences reached statistically significant values: 4,085 ± 71 g vs. 3,736 ± 73 g ($p < 0.01$). Thus, the marmots of the experimental group recovered faster after winter hibernation.

Key words: compound feed, meal, herbivorous fur-bearing animals, diet.

INTRODUCTION

Fruit processing products are widely used in the food industry. They enrich the human diet with the necessary biologically active and nutritious substances. Rowanberry powder as an unconventional ingredient with high nutritional and biological value was used in the development of gluten-free bread (Dubrovskaya et al., 2017). As supplement to wheat flour, powders of blueberries, rowanberries, pine nuts, sea buckthorn are used (Nilova & Malyutenkova, 2018; Nilova et al., 2019).

By-products of fruit processing are also used in animal feeding. In each region, there are non-traditional sources of feed rich with protein, amino acids, vitamins, inorganic substances, as well as biologically active elements. Using them allows to expand the range of feeds, contributes to increasing the productivity of animals (Mukhamedyanov et al., 2009).

Unclaimed by-products of plant raw materials processing in enterprises for the production of beverages, medicines, and for fruits canning can be promising ingredients for the production of compound feed. Preliminary calculations show that Russia has a sufficient amount of such ingredients to ensure the feeding of all herbivorous fur animals being breed in the country.

It is advisable to use ingredients from by-products of fruit processing that have nutritional value and useful properties in the production of complete feed: black chokeberry [*Aronia melanocarpa* (Michx.) Elliott] (Kokotkiewicz et al., 2010), common apricot [*Prunus armeniaca* L.] (Hayta & Alpaslan, 2011), black currant [*Ribes nigrum* L.] (Djordjević et al., 2013), sea buckthorn [*Elaeagnus rhamnoides* (L.) A. Nelson] (Skalski et al., 2019), cinnamon rose [*Rosa majalis* Herrm.] (Koropachinskiy & Vstovskaya, 2002), rowan [*Sorbus aucuparia* L.] (Klavins et al., 2016), Chinese magnolia vine [*Schisandra chinensis* (Turcz.) Baill.] (Panossian & Wikman, 2008), spiny eleuterococus [*Eleutherococcus senticosus* (Rupr. & Maxim.) Maxim.] (Arouca & Grassi-Kassisse, 2013) and others in the form of meal and flour obtained in the production of various beverages and oils. Biologically active elements that are present in by-products of fruit processing have a positive effect on the functioning of the body's systems and organs, on the productivity of animals (Prikryl et al., 2016; Toporova et al., 2018; Ferraz et al., 2019; Filatov et al., 2019).

The purpose of the research was to study the feasibility of using by-products of the industrial processing of fruits for the production of full-feed mixed fodders with the possibility of using these mixed feeds as the only feed in the diets of herbivorous fur animals.

MATERIALS AND METHODS

The study of compound feeds in experiments with farm animals by the method of Balakirev & Yudin (1994) was carried out at the Russian Research Institute of n.a. Prof. B.M. Zhitkov (VNIIOZ) and animal farm 'Vyatka' (Kirov region, Russia). The study followed the principles of international and Russian declarations and regulations on humane treatment of animals. The subjects of the study were nutria (*Myocastor coypus* Molina, 1782) (Fig. 1) and brown muskrat (*Ondatra zibethicus* Linnaeus, 1776) (Fig. 2) and steppe marmot (*Marmota bobak* Müller, 1776) (Fig. 3).

Figure 1. The nutria (*Myocastor coypus* Molina, 1782) (photo M. Mukhamedyanov).

For inclusion in the diet of experimental fur-bearing animals, batches of compound feeds were prepared with the inclusion of various

non-traditional ingredients. Specialists of VNIIOZ and the State Center of Agrochemical Service 'Kirovsky' studied the chemical composition and nutritional value of mixed feeds.

Figure 2. The brown muskrat (*Ondatra zibethicus* Linnaeus, 1776) (photo A. Matskova).

Figure 3. The steppe marmot (*Marmota bobak* Müller, 1776) (photo M.V. Plugina).

In all samples the following was determined: initial and hygroscopic moisture. The Kjeldahl titrimetric method for nitrogen determination and the calculation method for crude protein were used (GOST 13496.4-93, 2011). The mass fraction of crude fat was determined by fat-free residue in a Soxhlet apparatus (GOST 13496.15-2016, 2016). The method for crude fiber determination according to Genneberg and Shtoman was used (GOST 31675-2012, 2014). Phosphorus was determined photometrically (GOST 26657-97, 1999). Sulfur was determined by ashing with a mixture of nitric and perchloric acids and then by the turbidimetric method.Calcium, copper, iron, magnesium, manganese, potassium, sodium, zinc were determined by atomic absorption spectrometry (GOST 32343-2013 (ISO 6869: 2000), 2014) on the Spectr 5-3 spectrophotometer. Carotene was determined photometrically (GOST 13496.17-95, 2011). Sample studies were repeated 2–3 times, depending on method requirements.

The compound feed of the control batch included: 76% of wheat and barley grains, 11% of pea grains, 9% of sunflower seed cake, 1.4% of feed limestone (chalk), 1% of vitamin and mineral additives in the form of a premix for rabbits and 1% of meat and bone meal, 0.6% of sodium chloride salt. The dry matter content in this feed was at the level of 86%, the moisture content was 14% respectively.

Instead of part of wheat grain, barley, peas, sunflower seed cake and meat and bone meal, oilseed residues from sea buckthorn pomace (*Elaeagnus rhamnoides* (L.) A. Nelson), cinnamon rose (*Rosa majalis* Herrm.) and flour from pomace of rowan (*Sorbus aucuparia* L.), black chokeberry (*Aronia melanocarpa* (Michx.) Elliott), kernels of common apricot (*Prunus armeniaca* L.), roots of spiny eleuterococus (*Eleutherococcus senticosus* (Rupr. & Maxim.) Maxim.) were included in the experimental batches of compound feed. The quantitative content of ingredients in experimental batches of compound feed is presented in Table 1.

All compound feeds were produced in granular form. The diameter of the granules was 5 mm. Bunker feeders were used for feeding muskrats and marmots, and floor feeders were used for nutria. The animals were kept in cages with a range of metal mesh and a wooden house.

The first experiment was carried out on female muskrats 2 groups were formed (control and experimental), 24 heads in each group. Females were selected into groups on the basis of analogs, taking age (11 months) and body weight (mass) into account. The sisters were evenly divided into groups. The experiment was continued on the young animals obtained from the females after being deposited from their mothers. Out of 120 young animals, 2 groups of 30 females and 30 males in each were formed, taking age, weight and origin into account. The muskrats were kept in cages of 2 heads. The experimental group received compound feed No. 1. The duration of the experiment was 9 months.

The second experiment was carried out on young male nutria. 2 groups of males from among brothers of littermates were formed, 23 heads each, aged 109–112 days and weighing 1,514–1,518 g. The experimental group received compound feed No. 2. The duration of the experiment was 5 months.

The third experiment was carried out on young nutria from the age of 1 month. Females and males were kept separately. With the onset of physiological maturity, 2 groups of stocks were formed, 4 males and 18 females in each group. Experienced animals received compound feed No. 3. The duration of the experiment with the preparatory period was 9.5 months.

The third experiment was carried out on young nutria from the age of 1 month. Females and males were kept separately. With the onset of physiological maturity, 2 groups of stocks were formed, 4 males and 18 females in each group. Experienced animals received compound feed No. 3. The duration of the experiment with the preparatory period was 9.5 months.

The fourth experiment was carried out on 60 marmots at the age of 13 months. 2 groups of 15 females and 15 males in each were formed with equal live weight. The animals were kept in cages in pairs. Experienced animals received compound feed No. 3. The duration of the experiment was 6 months.

The digital materials of the experiments were processed by the method of variation statistics on an IBM personal computer using a package of statistical programs for processing the results of biological research taking into account the Student's criterion (Biostatistica, Excel). The arithmetic mean was calculated, the representativeness error M ± m. The result was considered reliable (statistically significant) at $p \leq 0.05$.

RESULTS AND DISCUSSION

By-products are obtained from fruits of plants that grow in the Volga-Vyatka region of the Russian Federation in the process of industrial processing. In the future meal and flour are produced from their marc. Chemical analysis shows that the content of pectin substances in the marc of Prunus Aronia reaches 1.7%, and organic acids up to 3.2%. The dry matter of Aronia Prunus contains: 11–13% protein with a total amount of amino acids of at least 9.5%, about 6% fat, up to 30% fiber, 7–8% sugars. The content of macronutrients is equal to: 0.65% calcium, 0.32% phosphorus (with an optimal ratio of these elements 2:1), 0.5% potassium and 0.2% magnesium. 9 mg of carotene is contained per kg, trace elements content, mg per kg: iron 228, manganese 86, zinc 41, copper 25.

The dry matter of processed rowan contains: 10% protein, 8% fat, 20% fiber, 14% sugar. Contained in 1 kg: 3.5 g of calcium, 2.5 g of phosphorus, 8 g of potassium, 1.3 g of magnesium, 0.3 g of sulfur, 71 mg of manganese, 296 mg of iron, 26 mg of zinc and 9 mg of copper. In the dry matter of black currant marc there is 12% protein, 18% fat, 23% fiber, 12% sugar. Contained in 1 kg: 5.4 g of calcium, 3.1 g of phosphorus, 5 g of potassium, 1.1 g of magnesium, 0.3 g of sulfur, 23 mg of manganese, 158 mg of iron, 18 mg of zinc and 14 mg of copper.

Apricot kernel flour contains up to 22% sugar, 3% organic acids, 1.5% pectin substances, and up to 25% oil. The dry substance of apricot flour contains: 42% protein, 22% fat, 6.5% fiber, 16% sugar. 1 kg of this flour contains: 3.7 g of calcium, 6.9 g of phosphorus, 1.3 g of potassium, 0.1 g of sodium, 0.3 g of magnesium, 0.2 g of sulfur, 58 mg of iron, 15.5 mg of manganese, 1.5 mg of copper and 2 mg of carotene. Sea buckthorn meal in terms of dry matter contained: 26% protein, 6% fat, 22% fiber and 7% sugar. The mineral content in 1 kg is: 2.5 g of calcium, 3.9 g of phosphorus, 7.3 g of potassium, 1.5 g of magnesium and sulfur, 107 mg of iron, 43 mg of zinc, 4 mg of copper and 2 mg of manganese. The obtained data indicate the possibility of widespread use of by-products of fruits in the composition of compound feeds instead of a certain proportion of legumes, cake, meal and animal feed additives (Plotnikov, 2012; Mukhamedyanov & Plotnikov, 2017).

The composition of experimental batches of feed is shown in the table (Table 1). In 100 g of compound feeds, the content of 1.1–1.3 MJ was determined based on energy nutrition. In the experimental batches of compound feed, in contrast to the composition of the control batch, less than 30% leguminous fodder, 9% - sunflower cake, 1% - meat and bone meal were contained. Due to the inclusion of the studied ingredients in compound feed and a decrease in the content of expensive grains of wheat, barley, peas, as well as the complete exclusion of sunflower seeds cake and meat and bone meal, the total cost of pilot batches of compound feed decreased by 18–21%.

The possibility of using experimental batches of feed was tested in the process of scientific and economic research. The research was performed on domesticated fur animals that are bred in animal farms. In the diet of muskrats and nutria, the studied compound feed was the only food. In the diet of steppe marmots, it was an additional ingredient. Palatability of the combined feed in the control and experimental groups amounted to 97–98%.

Testing in the production conditions of batch No. 1 was carried out in the first study. As a result, it was found that the inclusion of compound feed in the diet allowed to increase the number of commercial offspring per female muskrat by 0.8 heads, compared to the control group. Females who did not receive the studied compound feed gave only 5.4 heads of their offspring. The safety of young animals until the moment of depositing puppies from their mothers was approximately equal in both groups.

The separated young muskrat stock raised on compound feed from batch No. 1 reached body weight by seven months of age: males - 776 ± 14 g, females - 771 ± 17 g, against litter mates raised on compound feed from the control batch: males - 735 ± 12 g, females-722 ± 17 g. The difference in the groups of males and females is statistically significant ($p < 0.05$). Average daily gains of the experimental young stock was more than 5.5–6.8 percent, as compared to the control counterparts.

Table 1. Number of ingredients and chemical composition of experimental batches of feed

Indicators for the composition of ingredients and chemicals	Control	Number of ingredients and composition of experimental granulated feed		
		Batch No. 1	Batch No. 2	Batch No. 3
The composition includes the following ingredients, %:				
grain of wheat and barley	76	50	57	47
pea grain	11	5	-	10
sunflower cake	9	-	-	-
Meal obtained from marc, %:				
sea buckthorns	-	30	21	24
rosehip	-	5	3	-
Flour obtained from marc, %:	-			
rowan	-	-	-	8
black chokeberry	-	-	6	-
apricot kernels	-	-	11	9
Eleutherococcus roots	-	8	-	-
Meat and bone meal	1	-	-	-
Feed limestone (chalk), %	1.4	1.5	1.5	1.5
Sodium chloride salt, %	0.6	0.3	0.5	0.5
Premix for rabbits	1	-	-	-
Chemical composition of produced feed:				
Dry matter content in the feed, %	86	86	84	86
Content in dry matter, %:				
protein	17.6	17.7	17.9	19.1
fat	8.0	6.8	7.9	7.5
fibre	6.8	8.5	8.8	7.6
Macronutrient content in the feed, %:				
calcium	0.78	0.70	0.80	0.60
phosphorus	0.45	0.50	0.49	0.50
magnesium	0.26	0.16	0.18	0.17
potassium	0.69	0.71	0.69	0.77
sodium	0.49	0.40	0.41	0.46
sulfur	0.28	0.10	0.20	0.19
Content of microelements in feed, mg kg^{-1}:				
iron	744	273	396	649
zinc	104	41	49	33
copper	24	17	15	16
manganese	78	32	82	51
Content of carotene in feed, mg kg^{-1}:	14	10	14	16

The second experiment was performed on young males of in-cage nutria. For the experiment two groups of male litter mates were formed: 23 heads at the age of 109–112 days and a body weight of 1,514–1,518 g The experimental group of males was fed with compound feed from batch No. 2. The control group received compound feed of the above composition. For five months of experience, males in the experimental group had a higher average daily gain in body weight. In particular, the value of this indicator in the experimental group was 18.4 ± 0.94 g, and in the control group - 17.9 ± 0.91 g. As a result of the control slaughter, the optimal yield of hot carcass of males was established. A higher value of the output of the hot carcass was recorded in males of the experimental

group. It was 48.3%, and in the control group it was 0.4% lower. The average size of the skins that were obtained from males of different groups was equal. It was 2,117 cm^2.

In the third scientific and economic experiment, male and female litter mates received compound feed from experimental batch No. 3 for eight months. To study the reproduction indicators, groups of nutria young stock were formed. The control group included 4 males and 17 females, the experimental group - 4 males and 18 females. In groups animals of the control group were fed with ordinary compound feed, and the experimental group received compound feed from batch No. 3. After 45 days of feeding, in groups 28% of pregnant females were in the control group, and 32% in the experimental group.

To conduct scientific and economic experiments on steppe marmots feeding, two groups of one-year-old young animals of 30 heads were formed. The initial average mass of animals is equal in different groups. The number of females and males in each group was equal. A mixed-sex pair of marmots was kept in an individual cage. Each cage had a house. The experiment was carried out from May to September. After September, marmots prepare for winter hibernation and stop eating food. The compound feed from batch No. 3 was included in the diet of steppe marmots of the experimental group in the amount of 76% of the total nutritional value of the diet. The rest 24% was accounted for by the green mass of grasses. The control group with the same ratio of feed received conventional compound feed. On average, each marmot received 180 g of compound feed and 500 g of green grass mass. The actual consumption of granulated compound feed established by measurements was 98%, and the green grass mass - 70%.

Marmots of the experimental group from the very beginning of the experiment were outnumbered by control animals. In July, these differences reached statistically significant values. Experimental animals weighed $4{,}085 \pm 71$ g, and control animals - $3{,}736 \pm 73$ g ($p < 0.01$). In September, experimental animals also exceeded control animals by weight, but the difference is not reliable. The average daily gain for the period of weight gain in groups was 16.6 and 16.5 g. As a result, we conclude that marmots of the experimental group who received compound feed prepared according to the recipe No. 3 during the experiment recovered faster after winter hibernation, grew faster and gained the largest live weight. In preparation for hibernation, they were the first to reduce their live body weight, compared to control marmots.

CONCLUSIONS

The results obtained in experiments indicate that the diets of herbivory fur animals can include feed from meal and flour, which are obtained from by-products of industrial processing of fruits (sea buckthorn, cinnamon rose, rowan, black chokeberry, kernels of common apricot, roots of spiny eleuterococus). Due to the introduction of unconventioal ingredients in the composition of compound feeds, up to 30% of leguminous feed was saved, 9% - cake, 1% - meat and bone meal. This allowed to reduce the cost of the studied batches of feed by 18–21%.

The inclusion of new ingredients in compound feed gave a positive effect when growing herbivorous fur animals in cage conditions: nutria, muskrats and marmots. The number of commercial offspring per female of muskrat increased by 0.8 heads, compared with the control group. The set apart young muskrat grown on the experimental compound feed reached body weight by the age of seven months: males -

776 ± 14 g, females - 771 ± 17 g, versus littermates raised on compound feed from the control batch: males - 735 ± 12 g, females - 722 ± 17 g ($p < 0.05$). The average daily gain of the experimental young stock was 5.5–6.8% higher than that of the control counterparts. Male nutria in the experimental group had an average daily gain of 18.4 ± 0.94 g, and in the control group - 17.9 ± 0.91 g. With the content of nutria in the stocks by the 45th day pregnancy was established in 32% of females receiving the experimental feed, and in control - 28%. The marmots of the experimental group weighed 4,085 ± 71 g during the period of maximum weight gain at the age of 16 months, and the control ones weighed 3,736 ± 73 g ($p < 0.01$). All this testifies to the efficiency of using meal and flour from by - products of fruit processing in compound feed for herbivorous fur animals.

REFERENCES

Arouca, A. & Grassi-Kassisse, D.M. 2013. Eleutherococcus senticosus: Studies and effects. *Health* **5**(9), 1509–1515. doi: 10.4236/health.2013.59205

Balakirev, N.A. & Yudin, V.K. 1994. *Methodological guidelines for conducting scientific and economic experiments on feeding fur-bearing animals*. Moscow, NIIPZK, 31 pp. (in Russian).

Djordjević, B., Šavikin, K., Zdunić, G., Janković, T., Vulić, T., Pljevljakušić, D. & Oparnica, C. 2013. Biochemical properties of the fresh and frozen black currants and juices. *J. Med. Food*. Jan, **16**(1) 73–81. doi: 10.1089/jmf.2011.0256

Dubrovskaya, N., Savkina, O., Kuznetsova, L. & Parakhina, O. 2017. Development of gluten-free bread with unconventional raw ingredients of high nutritional value and antimicrobial activity. *Agronomy Research* **15**(S2), 1276–1286.

Ferraz, P.F.P., Ferraz, G.A.S., Schiass,I, L, Nogueira, V.H.B., Barbari, M. & Damasceno, F.A. 2019. Spatial variability of litter temperature, relative air humidity and skin temperature of chicks in a commercial broiler house. *Agronomy Research* **17**(2), 408–417. doi.:10.15159/AR.19.112

Filatov, A., Shemuranova, N., Konopeltsev, I., Plemyashov, K., Anipchenko, P. & Stekolnikov, A. 2019. The role of triterpene acids in boar reproduction. *Theriogenolgy* **137**, 134.

GOST 13496.15-2016. 2016. Forage, compound feed, compound feed raw materials. Methods for mass fraction of crude fat determination. City of Moscow: Standartinform, 9 pp. (in Russia).

GOST 13496.17-95. 2011. Feed. Methods for carotene determination. City of Moscow: Standartinform, 5 pp. (in Russia).

GOST 13496.4-93. 2011. Forage, compound feed, compound feed raw materials. Methods for nitrogen and crude protein content determination. City of Moscow: Standartinform, 15 pp. (in Russia).

GOST 26657-97. 1999. Forage, compound feed, compound feed raw materials. Methods for phosphorus content determination. City of Moscow, 10 pp. (in Russia).

GOST 31675-2012. 2014. Feed. Methods for crude fiber content determination using intermediate filtration. City ofMoscow: Standartinform, 9 pp. (in Russia).

GOST 32343-2013 (ISO 6869: 2000). 2014. Forage, compound feed. Determination of calcium, copper, iron, magnesium, manganese, potassium, sodium and zinc content by atomic absorption spectrometry. City of Moscow: Standartinform, 14 pp. (in Russia).

Hayta, M. & Alpaslan, M. 2011. Apricot Kernel Flour and Its Use in Maintaining Health. *Flour and Breads and their Fortification in Health and Disease Prevention.* Academic Press. 213–221. doi.org/10.1016/B978-0-12-380886-8.10020-0

Klavins, L., Kviesis, J., Steinberga, I., Klavina, L. & Klavins, M. 2016. Gas chromatography–mass spectrometry study of lipids in northern berries. *Agronomy Research* **14**(S2), 1328–1346.

Kokotkiewicz, A., Jaremicz, Z. & Luczkiewicz, M. 2010. Aronia plants: a review of traditional use, biological activities, and perspectives for modern medicine. *J. Med. Food.* Apr. **13**(2), 255–269. doi: 10.1089/jmf.2009.0062

Koropachinskiy, I.Yu. & Vstovskaya, T.N. 2002. *Woody plants of the Asian part of Russia.* Novosibirsk: Publishing House of SB RAS, Branch "Geo", pp. 359–360 (in Russian).

Mukhamedyanov, M.M. & Plotnikov, I.A. 2017. Prospects for industrial technology of breeding of muskrat. *Russian Agricultural Sciences* **43**(5), 427–429. doi: 10.3103/S1068367417050111

Mukhamedyanov, M.M., Plotnikov, I.A. & Solomina, E.S. 2009. Mixed feed from unconventional ingredients for herbivorous furbearers. *Russian Agricultural Sciences* **35**(5), 343–345. doi: 10.3103/S1068367409050164

Nilova, L. & Malyutenkova, S. 2018. The possibility of using powdered sea-buckthorn in the development of bakery products with antioxidant properties. *Agronomy Research* **16**(S2), 1444–1456. doi.org/10.15159/AR.18.055

Nilova, L., Malyutenkova, S. & Kruchina-Bogdanov, I. 2019. The impact of plant powders on acrylamide content in bakery products. *Agronomy Research* **17**(S2), 1401–1413. doi.org/10.15159/AR.19.076

Panossian, A. & Wikman, G. 2008. Pharmacology of *Schisandra chinensis* Bail.: An overview of Russian researchand uses in medicine. *Journal of Ethnopharmacology* **118**, 183–212.

Plotnikov, I.A. 2012. Cage housed marmot's diseases. *Proceedings of the Xth International Scientific Congress in Fur Animal Production*. 21–24 August 2012, Copenhagen, Denmark. *Scientifur* **36**(3/4), 177–179. doi: 10.3920/978-90-8686-760-8_25

Prikryl, M., Vaculik, P., Chladek, L., Libich, L. & Smetanova, P. 2016. The human factor's impact on the process of milking. *Agronomy Research* **14**(5), 1659–1670.

Skalski, B., Kontek, B., Lis, B, Olas, B, Grabarczyk, L, Stochmal, A & Żuchowski, J. 2019. Biological properties of *Elaeagnus rhamnoides* (L.) A. Nelson twig and leaf extracts. *BMC Complement Altern Med* **19**, 148. doi.org/10.1186/s12906-019-2564-y

Toporova, L.V., Bouazid, A.A. & Toporova, I.V. 2018. Energy protein complex from non-standard fruit of fruit trees instead of corn in the rations of broiler chickens. *Feeding of farm animals and feed production* **7**, 33–39 (in Russian).