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Effect of addition of yeast (*Saccharomyces cerevisiae*) and herb preparation to feed on selected physiological indicators, growth rate and pelt quality of growing arctic foxes

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Yeast (*Saccharomyces cerevisiae*) and oil-and-water preparations (extracts) of plants are used in feeding farm animals, improving their health and productivity. It was attempted to use a plant-origin preparation (extract) and spray-dried brewer's yeast as feed additives. The experiment was conducted on 80 arctic foxes of both sexes born in the first decade of May. An addition of a phytogenic preparation and yeast to feed did not show a negative effect on health or final body weight of growing foxes. Supplementation of diet with yeast increased the feed intake, leading to a higher weight and higher content of storage fat in the body. Moreover, an addition of yeast to feed significantly improved coat quality as assessed both *in vivo* and post-slaughter.

KEY WORDS: Arctic fox / plant extracts / yeast

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Oil-and-water plant extracts and preparations of yeast (*Saccharomyces cerevisiae*) have an advantageous effect on digestion processes in the small and large intestine of monogastric animals. Results of several studies [Doreau and Jouany 1998, Robinson *et al*. 1999, Robinson and Garrett 1999, Agarwal *et al*. 2000, Reuter 2001, Gugolek *et al*. 2004, Strickling *et al*. 2004; Zhang 2005, Dobrzański *et al*. 2006, Li *et al*. 2006], indicate that active substances present in yeast and in phytogenic preparations contribute to a reduced animal wastage and to higher production performance, due to the stabilization of bacterial flora in the digestive tract [Salek 2001]. Moreover, a higher immunological status was found in animals offered yeast or yeast extracts [Berleć and Tarczykowski 2004, Stella *et al*. 2007]. Thus, it was attempted to investigate the effect of a phytogenic additive containing a herb preparation or spray-dried brewer's yeast on growth rate and feed conversion in young arctic foxes.

Material and methods

Investigations were conducted on an Arctic fox fur farm located in western Poland on 80 foxes of both sexes born in the first decade of May. After weaning at the age of 7 weeks cubs were placed in individual cages and divided into four groups of 10 males and 10 females each, with identical numbers of animals of the same sex allocated to each group from each litter. **Group I** (control) was offered a standard diet used on the farm including extruded wheat, turkey offals and cod filleting waste, fish meal, meat and bone meal as well as turkey fat. All the components were mixed with water until an adequate homogeneity was obtained. The level of ME energy per 1 kg feed was 6296 kJ in the first period and 7975 kJ in the finishing period, when the adult coat was being formed. Nutritive value of the rations was estimated by the intake of feed components (Tab. 1). Concentration of basic nutrients in the feed met the requirements of the respective standards accepted for animal rearing. Feed intake was regulated using the *semi ad libitum* method, with the rule that refusals should not remain in feed troughs for hygienic reasons. The amount of feed consumed was measured daily, individually for each animal. Animals from **group II** were supplemented with a 2% of brewer's yeast in the ration. In **group III,** to the basic diet the herb preparation was added at a rate of 300g/t, while in **group IV** to the basic feed 2% brewer's yeast were added

Table 1. Characteristics of feed rations: A (during hair growth) and B (during adult coat forming)

Selected indicator	Ration	
	A (15.07-15.09)	B (15.09-01.12)
Metabolizable energy (kJ/kg)	6296	7975
Metabolizable energy from protein (%)	36.6	30.2
Metabolizable energy from fat (%)	43.6	53.6
Metabolizable energy from carbohydrates (%)	19.8	16.2

and a herb preparation at 300g/t feed. All animals were fed individually starting from the onset of the experiment at the age of 42 days (week 7) until the completion of the experiment. Body weight of foxes was recorded on week 7, 14, 23 and on week 29 when they were killed.

In November body conformation of foxes was scored (according to the Body Conformation Scoring Standard). During slaughter blood was withdrawn from each animal for versenate analysis and separately to obtain the serum. Hematological indicators were determined as well as proteinograms prepared and serum urea level estimated. Moreover, measured were the post-slaughter girth's circumference and barrel length (from the tip of the nose to the base of the tail).

During skinning and fleshing the subcutaneous adipose tissue and tissue remaining at the carcass were weighed. Moreover, fatness was determined by measuring the adipose tissue content of the body at slaughter. Pelts after the pelting procedure were graded by a pelt appraiser according to the requirements of the Polish Standard and guidelines for fox pelt grading).

Brewer's yeast spray-dried at a temperature of up to 70°C, contained 2724 Kcal energy / kg and 43% crude protein, 2.0% crude fat, 1.0% crude fibre, 6.6% ash, 34.0% BAW, 6.2% starch, 1.2% sugars, 3.2% lysine, 0.67% methionine, 1.7% methionine-cystein, 0.69% tryptophan, 2.3% threonine, 0.2% Ca, 1.40% P, 0.2% Na, 0.13% Mg, while 1 kg supplied 480 mg Fe, 100 mg Zn, 50 mg MN, 60 mg Cu, 1 mg Se, 125 mg vitamin B_1, 45 mg vitamin B_2, 45 mg vitamin B_6, 0.01 mg vitamin B_{12}, 3500 mg choline, 400 mg nicotinic acid, 100 mg panthothenic acid, 18 mg folic acid and 850 mg biotin (producer Inter Yeast www.interyeast.pl).

A herb preparation contained encapsuled essential oils, flavonoids, stimulating substances: paprika (*Capsinum annom*), chili peppers (*Capsilum frutescens*), garlic and onion as well as glutinous substances (mucilages), containing carbohydrates swelling at an addition of water. These compounds form a protective layer in the intestinal mucosa, protecting it against penetration of pathogenic substances (producer Fresta www.delacom.com).

The rough data were assessed statistically using the one-way analysis of variance (ANOVA). Differences among groups were verified for significance using Duncan test [Ruszczyc 1979].

Results and discussion

Table 2 presents feed, energy and protein intake. In the first period of hair growth (A) up to day 60 of life the feed intake was similar in individual groups. However, a trend could be observed indicating that the feed ration in group II, where a 2% addition of brewer's yeast was applied, was taken most willingly. Results given in Table 3 did not show differences in body weight gain or nutrient intake among groups. Weight at slaughter was also similar. Table 4 lists hematological indexes determined in blood that fall within reference limits for young dogs [Winnicka 2004]. Thus it

Table 2. Feed, metabolizable energy (ME) and nutrient intake during specified growth periods

Item	Group			
	I	II	III	IV
Total ration A intake (kg /60 days)	32.88	33.46	33.20	32.78
daily/animal	0.548	0.557	0.553	0.546
Total ration B intake (kg /75 days)	47.62	48.10	46.75	46.20
daily/animal	0.634	0.641	0.623	0.616
ME intake (kJ) in ration A	207045	210696	209059	206413
daily/animal	824	839	832	822
ME intake (kJ) in ration B	379809	383636	372872	368484
daily/animal	1210	1222	1187	1173
Ration A and B intake (kg /135 days)	80.50	81.56	79.95	78.98
daily/animal	1038	1052	1030	1017
Protein intake (kg) in ration A	4.02	4.09	4.06	4.01
Protein intake (kg) in ration B	5.76	5.82	5.66	5.59
Protein intake (kg) in rations A + B	9.78	9.91	9.72	9.60

Table 3. Growth rate of animals

Item		Group			
		I	II	III	IV
Body weight (kg)	mean	0.94	0.93	0.96	0.93
at week 7 of age	SD	0.23	0.18	0.22	0.23
Body weight (kg)	mean	3.69	3.71	3.73	3.78
at week 14 of age	SD	0.43	0.42	0.47	0.50
Body weight (kg)	mean	8.22	8.51	8.78	8.08
at week 23 of age	SD	1.14	1.65	1.87	1.20
Body weight (kg) at week	mean	10.51	10.93	10.91	10.77
29 of age (slaughter weight)	SD	1.76	2.65	2.57	1.92
Body weight gain (kg)	mean	2.75	2.78	2.78	2.85
for week 7-14 of age	SD	0.28	0.36	0.35	0.42
Body weight gain (kg)	mean	4.52	4.80	5.04	4.30
for week 14-23 of age	SD	0.96	(1.47)	(1.77)	(0.92)
Body weight gain (kg)	mean	2.29	2.42	2.13	2.69
for week 23-29 of age	SD	1.14	1.25	1.61	0.99
Body weight gain (kg)	mean	9.57	10.00	9.95	9.84
for week 7-29 of age	SD	1.77	2.69	2.58	1.93
Mean daily weight gain (g) for week 7-29 of age	mean	62	65	65	60
ME intake (kJ) per kg of body weight gain	mean	61324	59431	58485	58422
Protein intake (g) per kg of body weight gain	mean	1.02	0.99	0.97	0.97

may be stated that the preparations applied had no negative effect on animals' health. In group II values of hematological indexes occurred even better than in the other groups, but the differences were not found significant. Serum proteinograms quoted in

Table 4. Hematological indicators of blood at slaughter

Item		Group			
		I	II	III	IV
Leucocyte count (10^3 /mm^3)	mean	8.47	13.32	11.80	10.52
	SD	1.43	1.95	1.47	1.62
Erythrocyte count (10^6 /mm^3)	mean	8.06	9.28	9.15	7.24
	SD	0.57	0.56	0.27	0.88
Hemoglobin (g/dl)	mean	14.16	15.61	16.05	12.40
	SD	2.04	3.40	3.60	3.01
Hematocrit (%)	mean	45.54	52.47	51.60	45.43
	SD	5.91	6.75	7.37	5.91
Thrombocyte count (10^3/mm^3)	mean	467.00	591.33	521.44	380.80
	SD	4.10	3.30	3.90	6.70
Abnormal blood cells (%)	mean	14.19	14.37	14.12	14.67
	SD	0.20	0.20	0.40	0.30
Lymfocyte count (10^3/mm^3)	mean	3.87	2.10	2.45	2.61
	SD	0.73	0.38	0.34	0.72
Monocyte count (10^3 /mm^3)	mean	0.50	0.70	0.61	0.52
	SD	0.42	0.14	0.13	0.37
Granulocyte count (10^3 /mm^3)	mean	6.64	8.82	8.72	6.62
	SD	1.20	3.60	3.80	3.40
Lymfocyte (%)	mean	23.05	28.12	21.47	23.97
	SD	4.20	3.70	4.60	7.60
Monocyte (%)	mean	6.02	6.66	5.84	6.22
	SD	0.46	0.56	0.39	0.85
Granulocyte (%)	mean	70.92	65.21	72.68	69.54
	SD	0.90	1.30	1.20	1.00

Table 5. Proteinograms of blood serum

Item		Group			
		I	II	III	IV
Total protein (g/l)	mean	76.63	70.45	76.44	72.63
	SD	4.07	8.16	5.22	13.13
Albumin (g/l)	mean	39.64	40.46	39.42	40.39
	SD	6.80	13.50	4.88	8.66
α-globulin (g/l)	mean	10.85	10.51	11.44	10.04
	SD	1.17	1.50	1.96	2.84
β-globulin (g/l)	mean	12.37	12.52	13.77	11.00
	SD	1.87	5.09	2.99	1.45
γ-globulin (g/l)	mean	12.48	8.11	13.42	11.60
	SD	2.45	1.39	3.16	0.98
Urea (mm/l)	mean	6.60	3.47	6.18	4.01
	SD	3.02	0.45	3.03	2.38

Table 5, showing the health of animals, fall within the reference levels for young dogs [Winnicka 2004]. Due to a very wide intragroup variation the significant differences among groups for these serum components were not confirmed. Albumin level, indicating nutrient supply, and concentration of α- and β-globulins, were very similar

Table 6. Post-slaughter indicators of skin and carcass

Item		Group			
		I	II	III	IV
Weight of adipose tissue (kg)	mean	3.43[a]	4.05[b]	3.93[b]	3.40[a]
	SD	1.04	1.50	1.47	0.91
% adipose tissue in the body weight	mean	32.17[a]	36.09[b]	35.14[b]	31.41[a]
	SD	5.76	5.39	5.45	5.23
Girth circumference (cm)	mean	55.26	56.30	57.55	53.95
	SD	4.48	5.78	6.53	4.51
Barrel length (cm)	mean	66.58	67.80	68.70	66.90
	SD	2.95	3.68	3.10	2.81

[ab]Meanss in a row bearing different superscripts differ significantly at P≤0.05.

Table 7. Characteristic of pelt and coat

Trait		Group			
		I	II	III	IV
Colour type (points)	mean	2.80	2.75	2.70	2.80
	SD	0.42	0.44	0.47	0.41
Colour purity of coat (points)	mean	2.26	2.40	2.20	2.25
	SD	0.45	0.50	0.41	0.44
Quality of coat (points)	mean	6.05[a]	6.80[b]	6.15[a]	6.80[b]
	SD	0.78	0.89	0.81	1.00
Total score of conformation traits (points)	mean	17.00[a]	17.85[b]	17.10[a]	17.90[b]
	SD	0.67	1.35	1.12	1.12
Pelt length (cm)	mean	114.16	116.60	116.05	113.90
	SD	6.34	9.68	8.62	8.01
Pelt size (points)	mean	2.80	2.47	2.40	2.75
	SD	1.10	0.70	0.99	1.07
Pelt category (points)	mean	2.00[a]	1.60[bc]	1.95[ac]	1.50[b]
	SD	0.67	0.50	0.60	0.51
Pelt class according to the Polish Standard	mean	2.37	1.95	2.10	1.85
	SD	0.89	0.83	0.72	0.74
Pelt class according to pelt lot grading guidelines	mean	2.84[a]	2.40[b]	2.85[a]	2.25[b]
	SD	0.90	0.75	0.87	0.90
Weight of raw hide (kg)	mean	0.77	0.78	0.80	0.74
	SD	0.09	0.14	0.15	0.12
Weight of dry raw hide (g)	mean	580.74	606.35	609.65	559.60
	SD	71.2	109.7	119.7	97.5

[ab...]Means in a row bearing different superscripts differ significantly at P≤0.05.

in all groups. In turn, differences were recorded in levels of γ-albumins, indicating different degrees of stimulation in animals. In group II an addition of brewer's yeast to feed bound some antigens in the lumen of the digestive tract and thus the digestive tract mucosa was not stimulated with these bodies. Post-slaughter indexes of foxes are collected in Table 6. Significant differences were found in the weight of fat separated from the carcass. Table 7 presents quality indexes for coats and dry raw pelts. An

addition of yeast (group II) and of plant-origin preparation (group III) resulted in an increased body weight of animals and thus also their size. It could have been expected, since also barrel length in animals of these groups was bigger in comparison to the two other groups (I and IV).

During the formation of coat no significant differences were observed in feed intake during 75 days (period B). In group II, where a 2% addition of brewer's yeast was used, feed was taken most willingly. An addition of the herb preparation (group III) slightly reduced feed intake. Probably the addition of essential oils, contained in the preparation, resulted in its deteriorated palatability. In group IV (application of both additives) a lower feed intake was also recorded. Total feed intake (A + B) in groups III and IV, where the addition of this phytobiotic was used, occurred by 1 to 2 kg lower than in the control and in group II – with an addition of brewer's yeast. In available literature no information has been found indicating how phytobiotics affected performance traits of foxes. The result in question may indicate that phytobiotics and the essential oils they contained reduced feed palatability. Similarly, no information is available concerning the effect of brewer's yeast on feed intake by foxes. However, the results presented here indicate that the addition of brewer's yeast enhances feed palatability. It is currently attempted in Poland to use such an additive in dog's feed. However, no detailed studies are being conducted on the subject. According to Inter Yeast, a producer of yeast used in this experiment, *i.e.* type S – spray-dried (www.interyeast.pl) – an additive of yeast in feed had an advantageous effect on hair quality in coats of dogs. Zduńczyk [2004] reported that active substances of yeast improved absorption of biotin, which is directly related to the quality of coats in animals.

No significant intergroup differences were recorded in intake of energy and protein. However, it needs to be stressed that animals from group II throughout the entire rearing period consumed more nutrients than did those from remaining groups. Hematological indexes fell within reference limits for young dogs [Winnicka 2004]. Thus it may be stated that none of the applied preparations had a negative effect on health of animals. In group II values of hematological indexes were better than in the other groups. A superior health condition of animals from group II was probably caused by the addition of brewer's yeast. This result is related to better feed intake, higher body weight and higher fat content of carcass.

Serum proteinograms, showing the health of animals, fall within the reference levels for young dogs [Winnicka 2004]. Differences among groups for these serum components were not proven due to a very high intragroup variation. Albumin level, indicating nutrient supply and concentration of α- and β-globulins, was very similar in all groups. In turn, differences were recorded in levels of γ-albumins, indicating different degrees of stimulation in animals. For this reason the immune system was stimulated to a lower degree to synthesize antibodies. This occurred by enterotoxins of *E. coli* being bound by mannoses contained in yeast cells, which are excreted in faeces. A lack of link between the enterotoxins and digestive tract walls resulted in the absence of stimulation of the lymphatic tissue to immune response.

The lowest urea level of the serum in foxes from group II may be explained by a superior protein utilization by animals. The supply of nucleotides contained in yeast yielded a skeleton for the formation of amino acids and for this reason protein conversion occurred more efficient than in the other groups. Manufacturer of brewer's yeast, Inter Yeast (www.interyeast.pl) reports that an addition of this component makes digestion of plant nutrients more efficient (in this case it was an addition of 13-15% extruded wheat).

Animals from group II were the fattest – with fat weight by approx. 0.6 kg higher than in groups I and III This result may be explained by a higher feed intake by animals from this group and thus – increased storage fat reserves. Similar relations were found for the fat content of the body and may hardly be interpreted in terms of feed and nutrient intake. A high fat content of carcasses in animals from groups II and III may be explained by a higher nutrient intake. The other indicators*, i.e.* girth's circumference behind shoulder blades and barrel length, did not differ among groups.

Scarce publications concerning the effect of the use of probiotics and synbiotics in nutrition show their different effects on growth and development of fur animals. Tauson [1983, 1984] in a study on minks, and Balakiriev *et al*. [1994] and Gugołek *et al*. [1999] in studies on foxes recorded bigger body weight of animals fed with an addition of probiotics. Others, however – Dahle and Holstad [1998], Lorek *et al*. [2000] and Gugołek *et al*. [2004] – did not confirm a positive effect of an addition of probiotics to the diet on the final body weight and body weight gain in foxes and minks.

An addition of yeast (group II) and that of a plant-origin preparation (group III) resulted in an increased body weight of animals and thus also their size. It could have been expected, since also barrel length for animals in these groups was bigger in comparison to the two other groups (I and IV). As reported by Lyngs [1990], body weight and pelt length in Artic fox are markedly correlated and a simple regression occurs between these traits. The regression for 17-weeek old females was 84 g, which means that an increase in body weight by 84 g at a given age results in an increase in pelt length by 1 cm. According to Lyngs [1990], it could be related to fat deposition, but also body weight gain of animals. Such a possibility was also indicated by Zduńczyk [2004].

An addition of yeast (group II) as well as that of yeast and the phytogenic preparation (group IV) had an advantageous effect on an improvement of coat quality assessed *in vivo* (trait of coat quality) as well as after slaughter (pelt category). Better coat quality also had a decisive effect on an improvement of total conformation scores and pelt class (particularly in terms of the auction classification) coming from foxes from these groups. A significant improvement of pelt quality may be explained by biotin uptake in case of the addition of yeast, resulting in a higher hair quality. A similar effect was found for the addition of yeast to dog feed, resulting in improved quality of their coat [Middelbos *et al*. 2007].

Scarce publications concerning the effect of administered probiotics in feeding fur animals presented their varied effect on pelt quality. Jorgensen [1991, Balakiriev *et*

al. [1994] and Gugołek *et al*. [1999, 2004] showed a positive effect of an addition of probiotics to the feed on pelt quality in mink, arctic fox and silver fox. No effect of a preparation containing probiotic bacterial cultures on pelt size or analysed pelt quality parameters in mink was found by Lorek *et al*. [2000].

Summing up the results presented in this study it may be stated that an addition of a herb preparation and yeast to feed has no negative effect on health or final body weight of growing foxes. An addition of yeast to feed stimulated the feed intake resulting in a higher storage fat weight and its higher per cent content in relation to the final body weight. An addition of yeast to feed significantly improved coat quality assessed *in vivo* and post slaughter, thus improving the quality class of produced pelts.

REFERENCES

1. AGARWAL N., KAMRA D.N., CHAUDHARY L.C., SAHOO A., PATHAK N.N., 2000 – Selection of *Saccharomyces cerevissae* strains for use as a microbial feed additive. ***Letters of Applied Microbiology*** 31(4), 270-273.
2. BALAKIREV N., DROZDOVA E.I., LEONKO N., BEVZ N.I., EPIMOVA O.G., KUZIAKOV A.N., ABRAMOV N.A., BONDARENKO V.M., 1994 – Application on Bifidumbakteria in fur animal husbandry. ***Zootekhnija*** 7, 17-19.
3. BERLEĆ K., TARCZYKOWSKI A., 2004 – The influence of selected probiotics on level of macroelements in blood serum of calves. In Polish, summary in English. Zeszyty Naukowe AR we Wrocławiu, Zootechnika LI, 501, 19-23.
4. DAHLE H., HOLSTAD G., 1998 – Forsok med tilsetting av melkesyrekultur pa torrfor til rev**.** ***Norsk Veterinaertidsskrift*** 100, 715-717.
5. DOBRZAŃSKI Z., DOLIŃSKA B., CHOJNACKA K., OPALIŃSKI S., RYSZKA F., 2006 – The use of yeast in livestock feeding. In Polish, summary in English**.** ***Acta Scientiarum Polonorum***. Medicina Veterinaria 5(2), 49-66.
6. DOREAU M., JOUANY J.P., 1998 – Effect of a *Saccharomyces cerevisiae* culture on nutrient digestion in lactating dairy cows. ***Journal of Dairy Science*** 81(12), 3214-3221.
7. GUGOŁEK A., LOREK M,O., LIPIŃSKI K., 1999 – Attempt to use unconvenitonal supplement in growing polar foxes nutrition. ***Scientifur*** 3, 187-195.
8. GUGOŁEK A., LOREK M.O., ZABŁOCKI, W. HARTMAN A., 2004 – Effect of probiotic preparation on the growth and the chosen parameters of hair cover quality of polar foxes. In Polish, summary in English. ***Zeszyty Naukowe Przeglądu Hodowlanego*** 72, 87-92.
9. JANIK A., KOSKA M., PALUCH U., PIESZKA M., BAROWICZ T., 2006 – Probiotics in piglet nutrition. In Polish. ***Wiadomości Zootechniczne*** XLIV, 3-9.
10. JŘRGENSEN M., 1991 – Probiotica til mink. ***Dansk Veterinaertidsskrift*** 12(4), 218.
11. JUKNA V., ŠIMKUS A., 2007: The influence of mixture of probiotics and fitobiotics on meat characteristics and quality in pigs. Veterinarija ir Zootechnika, 38 (60), 13-16.
12. LI J., LI D.F., XING J.J., CHENG Z.B., LAI C.H., 2006 – Effects of ß-glucan extracted from *Saccharomyces cerevisiae* on growth performance, and immunological and somatotropic responses of pigs challenged with *Escherichia coli* lipopolysaccharide. ***Journal of Animal Science*** 84, 2374-2381.
13. LOREK M.O., GUGOŁEK A., SZAREK J., PRZEŹDZIECKA D., 2000 – Effects of new generation supplement on some performance indices and health state in mink. ***Scientifur*** 4, 86-88.
14. LYNGS B., 1990: Vaegtuduikling og foderbrug hos solu-og blaracuehualpe**.** ***Dansk Pelsdyraval*** 6, 296-297.

15. MIDDELBOS I.S., GODOY M.R., FASTINGER N.D., FAHEY Jr. G.C., 2007 – A dose-response evaluation of spray-dried yeast cell wall supplementation of diets fed to adult dogs: Effects on nutrient digestibility, immune indices, and fecal microbial populations. ***Journal of Animal Science*** 85, 3022-3032.
16. REUTER G., 2001 – Probiotics-possibilities and limitations on their application in food, animal feed, and in pharmaceutical preparations for men and animals. ***Berliner und Munchener Tierarztliche Wochenschrift*** 114(11-12), 410-419.
17. Ruszczyc Z., 1979 – Doświadczalnictwo zootechniczne (Experimentation in Animal Science). In Polish. PWRiL, Warszawa.
18. ROBINSON P.H., GARRETT J.E., 1999 – Effect of yeast culture (*Saccharomyces cerevisiae*) on adaptation of cows to postpartum diets and on lactational performance. ***Journal of Animal Science*** 77, 988-999.
19. SALEK A.T., 2001 – Yeast antimicrobial proteins. ***Biotechnology*** 4 (55), 135-162.
20. STELLA A.V., PARATTE R., VALNEGRI L., CIGALINO G., SONCINI G., CHEVAUX E., DELL'ORTO V., SAVOINI G., 2007 – Effect of administration of live *Saccharomyces cerevissae* on milk production, milk composition, blood metabolites, and faecal flora in early lactating dairy goats. ***Small Ruminant Research*** 67, 7-13.
21. STRICKLINGA J.A., HARMON D.L., DAWSON K.A., GROSS K.L., 2000 – Evaluation of oligosaccharide addition to dog diets: influences on nutrient digestion and microbial populations. ***Animal Feed Scienc and Technology*** 86, 205-219.
22. TAUSON A.H., 1983 – Mjolksyrajasade bakterier i foder til mink under draktigetes och digiviningsperioden ***Vara-Palsdjur*** 11, 316-318.
23. TAUSON A.H., 1984 – Effects of lactic acid bacteria as feed additive on reproductive performance and early kit growth in mink and blue foxes. ***Acta Agriculturae Scandinavica*** 31, 227-236.
24. WINNICKA A., 2004 – Reference values of basal veterinary laboratory examinations (in Polish). Warsaw University of Agriculture.
25. ZDUŃCZYK Z., 2004 – Physiological effect of low digestible oligosaccharides in diets for animals and humans. Polish Journal of Food and Nutrition Science 13/54, 115-130.
26. ZHANG A.W., LEE B.D., LEE S.K., LEE K.W., AN G.H., SONG K.B, LEE C.H., 2005 – Effects of yeast (*Saccharomyces cerevisiae*) cell components on growth performance, meat quality, and ileal mucosa development of broiler chicks. ***Poultry Science*** 84 (7), 1015-1021.
27. www.interyeast.pl
28. www.delacon.com