

# Invited Speakers

## S5.3

### Physiological and Environmental Aspects in the Nutrition of Breeding Ducks and Geese

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Geese and ducks have a capacious gastrointestinal tract and are able to consume large amounts of feed mixtures, green fodders and home-made roughages rich in structural carbohydrates. Waterfowl are able to retain more depot fat than hens what cause the necessity to limitate the energetic value of diets also during reproductive season. The maximum energy value of mixtures ranged from 11.0 to 11.2 MJ/kg for ducks and ca. 11.7 MJ/kg of mixture for geese. The protein concentration must ranged from 16.0 to 18.5-20 % for breeding ducks and 14-18 % in the diets for geese. The excrements from waterfowl contain about 10-15 % of dry matter and because of this and additionally strong odours are the serious ecological problem.

**Keywords:** breeding, geese, ducks, nutrition

#### Some data on gastrointestinal tract in waterfowl

Geese and ducks, to a great extent, being herbivorous birds, are able to consume green forages and some root crops. They can be kept on fish ponds (ducks) or in free range systems. Geese may well utilize pastures, too. During the resting period, these poultry species may be fed cheap home-made roughages (roots, silages), i.e. they can eat 100-400 g of roots, 200-500 g of green fodders, 30-100 g grass meal. Very strong and wide beaks of geese with sharp edges allow them to cut the fibre-rich green feedstuffs. Both species are characterized by the wide and elastic oesophagus that makes possible to intake and swallow larger feed particles. The pressure inside a goose gizzard varies between 265-280 mmHg and is almost twice higher compared to hen's (100-150 mmHg) or duck's (about 180 mmHg) (Han and Shao,1988) what allow to crush the fibrous feedstuffs. The length of geese alimentary tract is visibly greater than that in ducks or hens (Table 1).

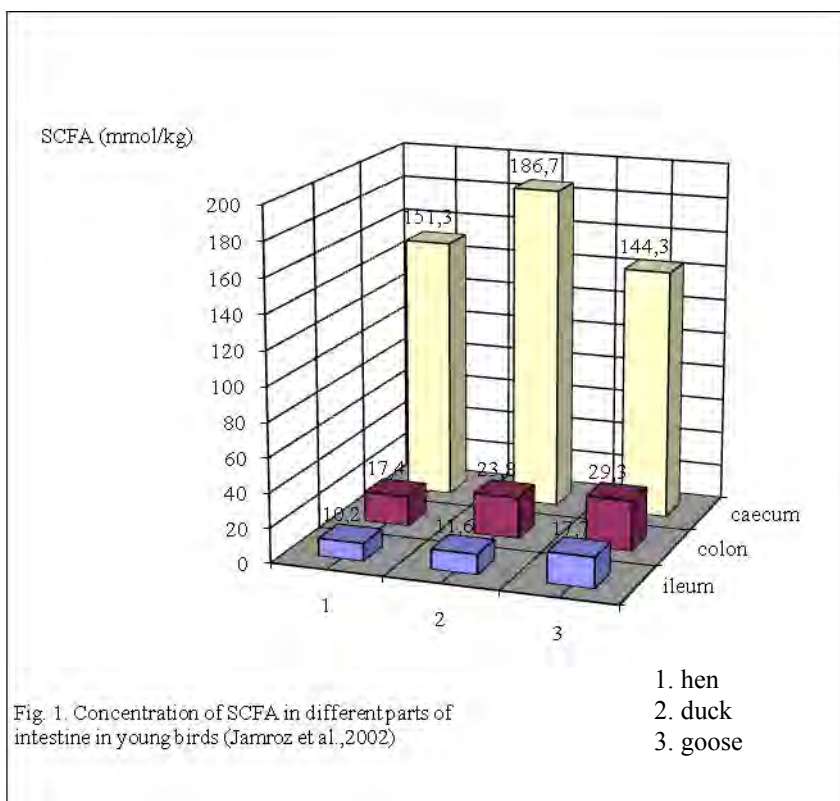
**Table 1. Allometric parameters of gastrointestinal tracts (GITs) in different poultry species (cm)**

Total length of GITs	Hen	165 - 210
	Duck	155 - 233
	Goose	250 - 365 - 400
Caecum	Hen	11 - 25
	Duck	17 - 40
	Goose	22 - 41 - 87
Length of intestine/length of body	Hen	5-8 : 1
	Duck	4-9 : 1
	Goose	5-11 : 1

The long and capacious GIT, specially the caeca in geese (Table 1), indicates much more intensive microbial processes occurring during the degradation of fibre-rich feed components than in other birds (Han and Shao,1988; Jamroz *et al.*1992, 2002; Wiliczkiwicz *et al.*,1992). The intestines, particularly the caeca, are settled by the numerous microorganisms (Su Wenjin and Zhang,1988) e.g. *Enterobacteriaceae* spp. ( $10^8$ /g of digesta), aerobic bacteria ( $10^7$ /g), *Bacterioides* ( $10^8$ - $10^9$ /g), *Fusobacterium* ( $10^6$ - $10^8$ /g), *Lactobacillus* spp. ( $10^7$ - $10^8$ /g), *Clostridium* ( $10^5$ - $10^7$ /g).

The intensive microbial degradation of structural carbohydrates occurring in caecums is also indicated by the high activity of cellulolytic enzymes (Han and Shao,1988; Yu *et al.*,1998; Wiliczkiwicz *et al.*,1992) and large quantities of synthesised short chain fatty acids (SCFA) which varied between 120-190 mmol kg<sup>-1</sup> of the contents in this part of the GIT (Jamroz *et al.*,1996). The highest values of SCFA concentrations were stated in caecal content in ducks (Fig. 1).

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The relatively high digestion of nutrients from roots and green fodders determined in our investigations carried out with geese varied between 9-28 % for crude fibre, 56-76 % for hemicelluloses, 49-62 % for pectins and 76-88% for crude protein (Jamroz and Bieliński, 1975; Pakulska *et al.*, 1982; Jamroz *et al.*, 1992). Good conversion of home-made roughages proves that ducks and geese are often treated as "ecological" birds. Moreover, geese are called "ruminants" among poultry species.

**Table 2. Changes of some blood indices in geese (Rossi *et al.*, 1984)**

Parameters	Sex	Winter	Spring	Summer	Autumn
Total lipids (g/100 ml)	F	2.82	1.90	0.93	2.05
	M	0.82	0.77	0.73	0.80
Triglycerides (mg/100 ml)	F	1512	968	293	1171
	M	127	137	109	137
Phospholipids (mg/100 ml)	F	1151	773	451	860
	M	377	337	348	374
Total - P (mg/100 ml)	F	60.6	40.0	21.0	42.9
	M	17.9	16.6	16.6	18.5
Ca (mg/100 ml)	F	27.7	19.8	13.6	22.8
	M	11.1	11.3	10.8	11.3
Fe (mg/100 ml)	F	1009	642	402	802
	M	201	229	189	228
Transferrin (mg/100 ml)	F	1088	780	509	874
	M	533	523	456	506
Total protein (g/100 ml)	F	5.2	5.3	4.9	5.5
	M	4.8	5.0	4.6	5.3

**Table 3. Some data on concentration of pro- and vitamins in egg yolk ( $\mu\text{g/g}$  of yolk) (Karadas *et al.*, 2005)**

Item	Carotenoids	$\alpha$ -Tocopherol	$\gamma$ -Tocopherol
Housed duck	11.2	16.3	2.1
Free-range duck	34.0	68.1	3.2
Wild Mallard	61.3	94.3	3.1
Housed chicken	14.8	154.2	15.3
Free-range chicken	33.9	36.5	3.3

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**Table 4. Ducks genotypes, their egg weight, fertility and hatchability (Książkiewicz, 1995)**

Item	Year of laying	Genotypes						
		Khaki Campbell	Orpington	Khaki Campbell x Orpington	Pekin origin			
					Danish	French	English	Polish (P-33)
Egg weight, g	1	71.3	72.7	74.5	86.7	82.5	84.1	86.7
	2	70.4	69.8	72.8	85.0	79.7	81.5	86.1
Fertility, %	1	93.2	93.3	93.5	88.3	86.4	86.0	92.3
	2	89.5	91.1	90.9	77.4	79.2	76.9	87.0
Hatchability, from fertilized eggs, %	1	67.1	62.1	60.2	77.9	79.8	75.8	68.3
	2	65.3	59.7	66.3	77.6	78.5	64.2	68.4

Waterfowl, especially geese, are typical "seasonal" birds (Shi *et al.*, 2008). Both, laying and resting periods hardly depend on the season of year, duration of light in the day or lighting programme in the intensive production systems. Spectacular changes of biochemical blood parameters illustrate very well deep physiological processes which occur in the birds' organisms in different seasons of the year (Table 2). Changes of these parameters are distinctly seen in female geese as a consequence of intensive egg production, in ganders, producers of semen, the analysed blood indices are more stable (Rossi *et al.*, 1984).

Intake of green feeds rich in carotenoids cause that the eggs laid by ducks and geese contain great amounts of carotenoids and vitamin A, which can also be accumulated, to a great extent, in the liver (Jamroz *et al.*, 1985; 1991a,b; Karadas *et al.*, 2005) (Table 3). Depending on the genotype and species of birds, significant differences in some performance results (Table 4) and e.g. in the content of lipidous ingredients (fatty acids, lipophilic vitamins) in the liver could be observed. It could be a good explanation for the physiological diversity among birds within species (Table 5 and 6) and for difficulties in the determination of true requirements of these birds for nutrients and in precise nutrition of waterfowl as well.

As an effect of photoperiodic stimulation of gonadotropic hormones, secretion from the hypothalamus gland ovarian hormones - estrogen, progesterone, luteinising hormones, testes androgens, takes place at the beginning of the reproduction period (Sharp and Blanche, 2003).

**Table 5. Comparison of some fatty acids share in polar lipids in waterfowl egg yolk (% in total fatty acids) (Adachi *et al.*, 1988)**

Fatty acids	European goose	Chinese goose	Muscovy duck	Hen
C 16:0 (palmitic)	31.0	33.8	35.5	29.5
C 16:1 (palmitoleic)	1.4	2.4	1.3	1.6
C 18:0 (stearic)	16.4	10.6	14.3	15.9
C 18:1 (oleic)	38.4	40.9	30.5	33.4
C 18:2 (linoleic)	5.9	6.4	6.6	13.1
C 18:3 (linolenic)	5.2	5.9	10.2	5.5

**Table 6. Effects of genotype on total water, protein, lipid, triglyceride, phospholipid and cholesterol levels (g/100 g tissue) in livers (Chartrin *et al.*, 2006)**

Genotype	Water	Proteins	Lipids	Triglycerides	Phospholipids	Cholesterol
Muscovy	69.62	21.14	6.08	3.59	2.08	0.41
Mule	71.11	18.75	4.41	2.05	1.84	0.52
Pekin	70.31	19.11	5.44	3.18	1.70	0.56
Interaction effect	***	**	**	***	ns	ns

\*\* P<0.01; \*\*\* P<0.001; ns - not significant

14-week-old ducks were euthanised after more than 12 h after their last meal (mean, n=8)

## Nutrition of breeding ducks

Between 25-27 weeks of life, the ducks begin the reproduction period. Recommendations for nutrients of these birds which are presented in different sources indicate that, depending on genotype, the intensity of nutrition of breeders in the rearing period (Table 7) and laying both intensity and level of the requirements for crude protein may vary between 15-18.5 even 20 %; 0.6-0.95 % for lysine and 0.5-0.8 % for Met + Cys (Tables 8-10). The recommendations for energy in diets for ducks may vary from 11.1 to 12.2 MJ ME/kg of feed mixture. The anticipated Ca level in the diets for laying ducks ranged from 2.7-3.1 %.

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Ducks are sensitive to the vitamin content in the diets, however there is a lack of data presented in the scientific papers. Differences among recommendations for vitamin A level range from 8000-15000 IU and from 1000-4000 IU for vit. D<sub>3</sub> and Vit. E - 20 mg in kg of feed mixture. This makes it impossible to evaluate the strict requirements of ducks for these lipophylic vitamins. The deficit of niacin (Vit. PP) causes the rachitis-like symptoms. The requirements of growing Pekin ducks for vitamin PP amounted to about 70 mg/kg, of Muscovy ducks – to about 25 mg and of adult birds of both breeds - to 50 and 25 mg/kg, respectively (Polish Standards of Poultry Feeding,2005).

**Table 7. Feeding of the meat-type reproductive ducks - compilation of different data from Leeson and Summers (1991) and NRC (1994)**

Nutrients		Period of rest		Laying period		NRC, 1994
Crude protein	%	11.0	13.0	16.0	18.0	15.0
Amino acids	g/kg					
Lys		4.4	5.0	8.0	9.5	6.0
Met		2.0	2.3	3.4	3.7	2.7
Met + Cys		4.2	4.5	5.8	6.4	5.0
Try		1.1	1.3	1.3	1.5	1.4
ME	MJ/kg	10.5	10.9	11.3	11.9	12.2
Ca	%	0.95	1.10	2.80	2.90	0.16
P available		0.38	0.42	0.38	0.42	-
Na		0.15	0.15	0.16	0.16	-

In 1 kg: vit. A 5.000-10.000 IU; D<sub>3</sub> 1.250-2.500 IU; E 12.5-25 mg; vit. K 1-2 mg; choline 400-800 mg; B<sub>2</sub> 2.7-5.5 mg; panthotenic acid 2.5-5.0 mg; B<sub>12</sub> 0.07-0.014 mg, folic acid 0.2-0.5 mg; biotin 0.12-0.25 mg; niacin 25-50 mg; B<sub>1</sub> 1-2.0 mg; B<sub>6</sub> 1.5-3.0 mg; Mn 30-60 mg; Fe 46-80 mg; Cu 4-8 mg; Zn 30-60 mg; Se 0.15-0.3 mg; I 0.2-0.4 mg

**Table 8. Feeding programmes for growing and laying ducks (Grimaud Freres) (2004)**

Item		Starter feed 0-3 weeks	Grower feed 4-10 weeks	Rearing feed 11-21 weeks	"Laying" feed 22 weeks-end of lay
ME	Kcal/kg	2850	2850	2700	2630
	MJ/kg	11.9	11.9	11.3	11.0
C. protein	%	21.0-23.0	17.5-19.0	14.5-16.0	17.5-20.0
Met	%	0.50	0.40	0.30	0.50
Met + Cys		0.90	0.70	0.60	0.80
Lys		1.00	0.80	0.70	0.94
Thr		0.70	0.55	0.45	0.60
Try		0.20	0.16	0.16	0.18
C. fibre	%	to 4.00	to 5.00	to 6.00	to 5.00
Fats		to 4.00	to 4.00	to 4.00	to 5.00
Ca		1.0-1.2	0.9-1.0	0.9-1.0	3.0-3.2
P available		0.40	0.35	0.35	0.40
Na		0.14-0.18	0.14-0.18	0.14-0.18	0.14-0.18
Cl		0.16-0.21	0.16-0.21	0.16-0.21	0.16-0.21
K		to 0.83	to 0.80	to 0.80	to 0.80
Linoleic acid	%	1.00	1.00	1.00	1.50

**Table 9. Recommendations for feeding of Muscovy breeding ducks (Polish Recommendations of Poultry Feeding,2005)**

Nutrients		Growing birds Age (in weeks)		From 11 <sup>th</sup> week and the resting period	Reproduction since 27-29 week of life
		0-3	4-10		
EM <sub>N</sub>	MJ/kg	11.9	11.9	11.3	11.1
C. protein	%	21.5	18.0	16.0	16-18
C. fibre		to 4.0	to 5.0	to 6.0	to 5.0
C. fat		to 4.0	to 4.0	to 4.0	to 5.0
Lys	%	1.10	0.95	0.70	0.90
Met		0.50	0.45	0.30	0.45
Met+Cys		0.90	0.75	0.60	0.70
Thr		0.70	0.60	0.50	0.55
Try		0.20	0.16	0.16	0.16
Ca	%	1.00	0.90	0.90	3.10
P avail.		0.45	0.40	0.40	0.40
Na		0.16	0.16	0.16	0.16
Cl		0.18	0.18	0.18	0.18
Zn	mg/kg	40	30	20	60

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**Table 10. Recommendations for feeding of meat-type breeding Pekin ducks (Polish Recommendations of Poultry Feeding, 2005)**

Nutrients		Growing birds		Adult birds	Reproduction since 27 week of life
		Age (in weeks)			
		0-3	4-10	11-26	
EM <sub>N</sub>	MJ/kg	11.9	11.9	11.1	11.1
C. protein	%	22.0	18.0	15.0	18.5
C. fibre		to 4.0	to 5.0	to 6.0	to 5.0
C. fat		to 4.0	to 4.0	to 4.0	to 5.0
Lys	%	1.00	0.80	0.65	0.95
Met		0.50	0.40	0.30	0.50
Met+Cys		0.90	0.70	0.60	0.80
Thr		0.70	0.60	0.45	0.60
Try		0.20	0.16	0.15	0.18
Ca	%	1.00	0.95	0.75	3.10
P avail.		0.40	0.35	0.35	0.40
Na		0.16	0.16	0.16	0.16
Cl		0.18	0.18	0.18	0.18
Mg		600	500	500	600
Mn	mg/kg	75	65	45	65
Zn		70	60	60	60
I		0.35	0.35	0.30	0.30
Se		0.20	0.20	0.15	0.20
Vit. A	IU/kg	15000	15000	10000	15000
Vit. D <sub>3</sub>		3000	3000	2000	4000
Vit. E	mg/kg	20	20	15	20
Vit. K		2	1	1	2
Vit. B <sub>1</sub>		2	1.8	1.8	2
Vit. B <sub>2</sub>		4.5	4.5	3	4.5
Vit. B <sub>6</sub>		3	3	3	3
Nicotinic acid		70	70	50	50
Pantothenic acid		12	11	10	15
Folic acid		0.5	0.25	0.25	0.5
Vit. B <sub>12</sub>		0.01	0.005	0.005	0.01
Biotin		0.15	0.1	0.01	0.15
Choline		1300	1000	600	1000

## Nutrition of breeding geese

The future performance of reproductive waterfowl, in them also geese flocks, depends to a great extent on the intensity of rearing of young birds. The protein level in mixtures may vary from 22-20 % (0-3 weeks) to 14 % (from 13 weeks to reproductive maturity). Energy density in mixtures must reach the amount between 11.7-10 MJ/kg; Ca level 1.0-0.6 %; lysine 1.1-0.73 %, methionine 0.48-0.32 %. The intensive nutrition during the growth phase improves the reproduction results obtained in the first year of utilisation; however, controlled rearing assures better results in reproduction parameters of laying geese in 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> or even to 10<sup>th</sup> year of keeping (Bieliński and Rosiński, 1988). This is very important for the economical calculation of feeding expenses. One reared young goose can consume in total about 21-24 kg of feed mixtures. Application of green fodders from the 9<sup>th</sup> week of life and in the resting period may be helpful to minimise the feeding costs.

Under European conditions, in the semi-intensive production systems, in December geese usually start to prepare to the reproduction period; at the end of January, the first eggs are laid and the laying periods lasts till June or July, depending on the weather circumstances.

The not numerous publications and recommendations of nutrient concentration in feed mixtures vary, to a great extent, depending on the genotype of geese and environmental conditions. they are presented in Tables 11 and 12.

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**Table 11. Recommendations of geese layers nutrition (Leeson and Summers,1991; Polish Recommendations of Poultry Feeding,2005)**

Compounds		Periods		
		Resting period	Start to lay	Laying
EM <sub>N</sub>	Kcal/kg	2300-2450	2550	2680
EM <sub>N</sub>	MJ/kg	10.2-10.0	10.6	11.1
C. protein	%	12.0-14.0	13.5-14.0	14.0-16.0
C. fibre		to 10.0	to 7.0	to 5.0
Lys	%	0.50	0.58-0.59	0.64-0.66
Met		0.20	0.21-0.23	0.26-0.32
Met + Cys		0.45	0.43-0.47	0.47-0.60
Tre		0.40	0.42-0.50	0.52-0.58
Try		0.12	0.13	0.14-0.15
Ca	%	0.80-0.90	1.10-1.90	2.50-2.80
P-total		0.60-0.70	0.60	0.60
P-avail.		0.35-0.38	0.35-0.38	0.40
Na		0.13	0.14	0.15
Cl		0.12	0.14	0.14
Mn	mg/kg	30-50	40-60	60
Zn		40-50	60	60-80
Fe		30-50	40	40
I		0.2-0.7	0.42-1.0	0.42-1.0
Cu		4.0-5.0	4.0-5.0	8.0
Vit. A	IU/kg	5000-6000	8000	10000-15000*
Vit. D <sub>3</sub>		500-1000	700	1000-1200-2000
Vit. E	mg/kg	10	15-20	20
Choline		900	1000	800-1500

\* in the case of weaker hatchability effects

**Table 12. Nutrients characteristics for breeders geese (Grimaud Freres,2004)**

Item		Maintenance feed	Layers feed
		Min	Min
ME	Kcal/kg	2700	2800
	MJ/kg	11.3	11.7
C. protein	%	14.5-16.0	16.0-18.00
Met	%	0.30	0.40
Met + Cys		0.60	0.70
Lys		0.70	0.80
Thr		0.45	0.55
Try		0.16	0.16
C. fibre	%	to 6.00	to 6.00
C. fat		to 4.00	to 5.00
Ca	%	0.9-1.0	3.0-3.2
P avail.		0.35	0.35
Na		0.14-0.18	0.14-0.18
Cl		0.16-0.21	0.16-0.21
K		0.80	0.80
Vit. A	IU./kg	12000	12000
Vit. D		2000	2000
Vit. E	mg/kg	20	20
Linoleic acid	%	1.0	1.4

It is an essential problem in geese nutrition to feed the ganders which are kept together with females as they may consume feeds and nutrients over their real requirement. Obesity of ganders may decrease the reproductive parameters (fertility of eggs) and it is sometimes observed at the end of April or in the first days of May. In such situation, the change of ganders to female geese ratio (optimum 1:5) or the introduction of younger males can stimulate the sexual behaviour and performance of birds .

Geese demonstrate very good adaptation to different protein levels in diets (Bielińska *et al.*,1993; Bieliński *et al.*,1976a,b;1985; Buckland and Guy,2001; He *et al.*,2003; Jamroz,1994; Pakulska *et al.*,1986). The application of 13.5 % crude protein and 10.5 MJ per kg mixture for laying geese allowed to obtain about 70 eggs characterised by good fertility parameters (45-56 goslings per geese). In geese nutrition, it is very important to control precisely energy density in the diet, which cannot be higher than 11.1-11.2 MJ ME/kg diet (Bieliński *et al.*,1980; Saveur *et al.*,1988a,b; Bogenfürst,1998; Jamroz 1992a;1994;).

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During resting period geese intake about 24-30 g of crude protein and about 2.1-2.3 MJ ME/head/day; in the coming to lay period - 30-25 g protein and 2.5-2.8 MJ ME and during laying - 52-60 g crude protein and about 3.8 MJ ME per head per day. These birds consume from 270 to 300 or 400 g feed mixture a day and the concentration of nutrients must be adjusted to the amounts of received mixtures.

The use in mixtures of some components, such as: field beans, peas, rapeseed meal, grass meal, maize cobs and others has no negative effects on performance parameters (Bieliński *et al.*, 1976b; 1979, 1991; Thongwittaya, 2007).

The real requirement of geese for vitamins is not recognized well. Moreover, rare publications give inconsistent data on the subject (Table 13; Chen, 2000). Green fodder and maize eaten by geese are rich in carotenoids occurring in concentration of 20-27 mg/kg or more; these compounds from diets stimulate the progesteron synthesis. Geese eggs contain more vit. A (3720-7400 IU/100 g) than eggs laid by hens (3000-3200 IU/100 g). Higher doses of applied vit. A are successfully used in practical conditions (to 20000 IU/kg feed) to improve the geese eggs hatchability (Jamroz 1992b). The vitamin-like substances originating from carotenoid bounds - esters of apo-carotenoid acid - exert profitable effects on reproduction parameters. Higher vitamin E supplements (over 20 to 40 mg) increase the fertility of eggs (Surai and Ionov, 1992). The requirement of geese for "hatching" vitamins - amid of nicotinic acid (niacine) amounted to about 60 mg/kg and for panthotenic acid - to about 12 mg/kg of mixture. Some feed components, such as grass, grass meal, carrots, oats can improve the reproductive potentials of geese. However, several plants rich in phytoestrogenes - lucerne or some herbs may decrease the spermatogenesis in males (Opałka *et al.*, 2008) and eggs numbers per one layer (author's observations).

**Table 13. Some older data on geese requirements for vitamins**

Vitamins		Scott, 1973	Jeroch, 1981	NRC, 1984	AEC, 1987*
Vit. A	IU/kg	11000	12000	4000	8000
Vit. D3		1500	1300	200	1000
Vit. E	mg/kg	25	30-34	-	15-20
Thiamin		-	2,0	-	1
Riboflavin		3.5	-	4	4
Pyridoxine		-	4-4.5	-	2
Niacin		60	22	20	-
Vit. K3		0.5	2.5	-	-
Panthotenic acid		15	15	-	5
Choline		1100	-	-	300

\* Standards for ducks

The productivity of geese in the intensive systems is strictly connected with lighting programs treated as the "controlling" instruments (Bieliński *et al.*, 1981; Brun *et al.*, 2003; Elminowska-Wende, 1987, 2005). The optimum lighting program during laying phase is 8 h light a day for geese, which physiologically are the "short-day" birds (Schneider, 1981). Application of different lighting and feeding programs allows to obtain more than 90 eggs per layer (Elminowska-Wende, 1986).

## Environmental problems in waterfowl keeping

The excretion of wastes containing only 10-15 % of dry matter in duck and geese amounted to ca. 40-75 kg per 100 birds/day (Jamroz *et al.*, 1983). These birds, depending on the kind of diets, can excrete into the environment about 0.8-1.5 kg of crude protein in different forms of N-containing substances and 0.8 to 3.0 kg of crude fibre when calculated per 100 birds/day. Also, large amounts of macro- and microelements are removed from organisms in geese excreta. The cleaning of poultry houses, transport and storage of large quantities of bulky, very wet (about 85-90 % water) excrements have a great impact on work expenses on waterfowl farms. The emission of ammonia (NH<sub>3</sub>), according to Lubac *et al.* (2004), amounts to ca. 15-41 mg/h per duck. Serious arduousness to the environment and people is connected with odours that are emitted from geese, more from ducks excrements. Management of these wastes in waterfowl farming requires systemic solutions to be used.

The nutrition of breeding waterfowl is greatly diversified depending on genotype, housing system, kind of employed feedstuffs, countries and tradition. All in all, it is more strongly connected with natural ecosystems and conditions than the nutrition of hens or turkeys in the period of reproduction. The small number of scientific papers on the nutrition of breeding flocks of waterfowl, especially geese, may indicate the decline of interest in keeping of these birds.

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