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Chemical composition of garlic preparation and its utilization in piglet diets*)

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Summary

The aim of these investigations was to determine the influence of garlic powder additives on gains, feed intake and conversion, and some biochemical blood parameters of piglets.

The investigations were carried out on 419 piglets from 36 sows, assigned randomly to 6 groups. The piglets of group I received the basal diets without antimicrobial growth promoters (AGP) and group II received the basal diets with AGP additive. The animals of experimental groups (III – VI) received the same diets as group I, but supplemented with lyophilized garlic powder in doses of 1.0, 2.0, 5.0 or 10.0 g per kg diet in groups III – VI, respectively. Piglets were weaned at 28 days of age. From the second week of age until 28th day after weaning, the piglets were fed a commercial Prestarter mixture ad libitum. Body weight was measured individually at birth, at the weaning period, and at the end of the trial (56th day of life). Feed intake by piglets was recorded weekly for litters in each pen. Blood samples were collected at weaning (28th day) and on day 56 after birth, and contents of protein, glucose, total cholesterol, HDL-cholesterol and blood urea nitrogen were determined. The garlic bulbs and garlic powder were analyzed for alliin and allicin concentrations.

Powder from lyophilized garlic clover additive, especially in 5 or 10 g/kg mixtures, may constitute a recommended dietary component for raising piglets up to 56 days of life. This procedure, an alternative for AGP use, improves body weight gains, decreases piglet losses as well as triglycerides and total cholesterol concentration in blood plasma.

Keywords: garlic preparation, piglets

In the last years an increased interest in utilization of growth promoters of natural origin has been observed (11, 13). This is connected not only with phytoterapy and prophylaxis in veterinary medicine, but also with practical application in animal feeding, as well (6, 8, 9, 17). Very promising seems to be the using the herb, especially biological activity substances, in food and feed supplements. The historic use of herbal remedies to treat and prevent infectious disease has been supplanted with the emergence of specific chemotherapeutic and antibacterial agents. Some investigations with herb mixture additive have been confirming an impact on performance and on some parameters of health characteristics (4, 17). Several veterinary medicinal herbs can be effectively grown in Poland. One of them these is garlic (*Allium sativum*). Garlic bulbs (cloves), like other herbs, have an exquisite defense system composed of as many different components as the animal immune system and antioxidant activity (5, 17, 22). In order to protect itself from bacteria's and fungi, garlic enzymatically produces allicin when it is crushed (1, 7). Many commercial garlic preparations are available, most of which contain either lyophilized garlic powder (LGP), aqueous garlic powder (AGP), aged garlic extract (AGE) or garlic oil (16, 21, 24, 26). Garlic and its preparations have been widely recognized as the agents for prevention and treatment of cardiovascular and other metabolic diseases, atherosclerosis, hyperlipidemia, thrombosis, hypertension and diabetes (3, 17, 19, 20, 23, 25). However in some scientific publications it has been reported to have certain benefits in animals: reducing total cholesterol and triglyceride (fat) concentrations and increase high density lipoproteins (HDL) in the blood and also an antithrombotic effect (8, 20). Effectiveness of garlic bulbs or garlic preparation additives to diet depends on bioactive components content, its daily intake or doses in feed and animal species (7, 15, 18, 24).

The aim of these investigations was to determine the influence of garlic powder additives on gains, feed intake and conversion, and some biochemical blood parameters of piglets.

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Material and methods

A total of 419 piglets (Polish Landrace × (Duroc × Pietrain)) both sexes, from thirty-six litters were used. The piglets were obtained from a production herd. The experiment was carried out in six blocks of 6 sows each. Piglets were weaned at 28 days of age. From the second week of age until 28th day after weaning, the piglets were fed *ad libitum* a commercial Prestarter mixture. The piglets of group I (negative control – NC) received the basal diets without antimicrobial growth promoters (AGP) and group II (positive control as AGP) received the basal diets with 20 mg avilamycin per 1 kg mixture additive. The animals of experimental groups (III-VI) received the same diets like group I, but supplemented with lyophilized garlic powder (LGP) in dose 1.0, 2.0, 5.0 or 10.0 g per kg diet in groups III-VI, respectively. The basal diet in Prestarter period contained wheat, maize, soybean meal, soybean oil, sucrose and skim milk and mineral-vitamins premix. The mixture contained 208 g crude protein, included 13.2 g total lysine and also 13.0 MJ EM. All piglets were individual marked with plastic ear-ring.

Body weight was measured individually at birth, at weaning period and at the end of the trial (56th day of life). Feed intake by piglets was recorded weekly for litter in each pen. After weaning, the piglets from each litter were transfer to one pen. Blood for analytical tests was taken from the cervical jugular vein from 36 piglets (3 gilts and 3 barrows from each group). At weaning (28th day) and on day 56 after birth, blood samples (10 mL) were collected in tubes containing heparin. Content of protein, glucose, total cholesterol and HDL-cholesterol in blood plasma were determined using colorimetric technique (Cormey kit). Blood urea nitrogen (BUN) was determined in deproteinized blood plasma samples by incubation of the sample with urease, followed by colorimetric analysis of ammonium, a modification of the Berthelot reaction.

Content of dry matter and nutrients in garlic bulbs, garlic preparations and piglet mixtures were determined according to AOAC (2). The alliin and allicin concentrations in garlic bulbs and powder were determined using HPLC methods (14).

Statistical analyses were used, according to ANOVA procedure, using Duncan test.

Results and discussion

The nutrients content (tab. 1) in garlic bulbs (GB) as well as in lyophilized garlic powder (LGP) and dehydrated (HGP) or in a dry preparation after water extraction of crushed garlic (GP) was found within the limits of values reported by the other authors (7, 23). Its quantity depends on the cultivation region and harvest date (19), fertilization, especially with sulfur (7, 23, 26) and a mode of preparation production from garlic (16, 21). The highest content of alliin, a precursor of numerous bioactive components of garlic, like allicin, ajoene, s-allylcysteine was detected in LPG. While converting into dry matter, the highest amount of alliin was stated in the fresh garlic bulbs. Far less alliin was recorded in HGP and its lack in GP. A level

Tab. 1. Chemical composition g/kg of garlic bulbs and their products

Components	GB	LGP	HGP	GP
Dry matter	312.4	965.8	931.6	934.8
Crude ash	14.82	41.52	37.83	20.32
Crude protein	61.43	176.22	158.05	78.38
Ether extract	6.53	17.31	14.28	2.19
Crude fibre	8.61	25.92	24.11	ND
Alliin	11.12	21,13	10,2	ND
Allicin	4.91	9,03	4,31	ND

Explanations: GB – garlic bulbs; LPG – lyophilized garlic powder; HGP – heated garlic powder; GP – garlic powder; ND – not detected

of alliin and products of its enzymatic breakdown is subject to the garlic origin, harvest period and methods of preparation obtainment. Currently the following liquid preparations are marketed: water-raw garlic juice and heated garlic juice, water-alcohol aged garlic extract and essential oils (16, 21, 24). Among the dried preparations, the attention should be drawn to garlic powder dried at circa 70°C or lyophilized or the preparations from concentrated water or water-alcohol solutions as garlic powder.

Having analyzed the preparations towards some active ingredients of garlic (alliin and allicin), the lyophilized powder garlic (LPG) was chosen for further studies on animals.

It appeared far easier to include it as a full dose mixture constituent than crushed cloves of fresh garlic. A LPG additive supplemented the Prestarter mixture for piglets 1 g/kg mixture in the group III, 2 g in group IV, 5 g in group V and 10 g in group VI. In the available investigations conducted on pigs, garlic powder was added at varied doses: for piglets from 0.5-1.5 g/kg mixture (18), 0.5-2.5 g/kg feed (15), it was dosed 0.2 g daily/piglet (17) or even up to 50 g/kg mixture over 1-5 week of life (13), whereas for fatteners 1 g or 10 g/kg mixture (9) and 2 g/kg mixture (12).

The piglets assigned to each experimental group were characterized with good vigor and similar body weight at birth ranging from 1.44 ± 0.02 kg (tab. 2). A number of piglets obtained from a sow oscillated from 11.2 up to 12.0 units in a litter. The comparison of animals from I (NC) and II (AGP) reveals that an avilamycin additive had clearly improved the performance of piglets up to 56 d of life. It was manifested with a higher growth of body weight and lower losses of piglets staying with the sow. Hence, the assumption was confirmed that the ban on AGP additive application in pig feeding leads to worse productivity effects and in turn, disturbances in the functioning of the digestive system flora (11). However, introduction of lyophilized garlic into mixtures for piglets allowed to get far better results as against the negative control (group I), while in group V and VI with 5 or 10 g of

garlic supplement the effects were close to group II supplied with dietary AGP. These beneficial results of a garlic preparation for piglet feeding were reported by the other authors (15, 17, 18, 24) and are contributed to sulfur and other bioactive components of garlic (18, 19). It should be emphasized that the groups given LPG supplemented feeds were characterized with very low losses of piglets as manifested in Jost studies (15).

The analyzed blood plasma indices (tab. 3) were contained within the reference values (10, 28). A protein content appeared to be slightly higher on 56 d compared to 28 d of piglet life. An additive of AGP or LGP did not affect significantly this component level in blood plasma. A concentration of blood urea nitrogen (BUN) on 28 d maintained at a similar level in each group and the peak was recorded in blood of piglets from group I (NC). Some significant differences in the BUN concentration were observed on 56 day of life. Both, the AGP and LPG additive, yet in higher amount (5-10 g/kg feed), significantly lowered the BUN concentration. A protein content and BUN concentration in pig blood can inform about a protein level and quality in a feed as well as a metabolism level and its direction in organism (27). A similar level of blood crude protein proves that the mixtures supplied to each group had a similar content and quality of feed protein. A decrease of the BUN concentration may indicate more efficient utilization of feed protein and as a consequence, the beneficial effect of an AGP or LGP supplement on its metabolism. A blood glucose level in piglets, though, turned out to be an index slightly susceptible to the changes the of experimental factors (AGP or LGP additive).

A hypocholesterolemic effect of bioactive garlic compounds in humans and animals is reported in many research publications (8, 19, 26), yet, the decreased cholesterol levels are attributable to numerous factors, in that a type of garlic preparation administered. On 28 d of piglet life, a mere downwards tendency of total cholesterol was observed in blood plasma of piglets fed a mixture with a LGP additive. At that period of life, the piglets' main feed is mother's milk so the additives to Prestarter mixture are of minor importance. On 56 day, however, some significant differences were recorded in a cholesterol level between

Tab. 2. Performance of piglets fed diet with varied amount of lyophilized garlic powder

	Feeding groups						SEM
	I – NC	II – AGP	III – LGP-1	IV – LGP-2	V – LGP-5	VI – LGP-10	
Garlic powder, g/kg diet	0.0	0.0	1.0	2.0	5.0	10.0	
Number of sows	6	6	6	6	6	6	
Number of liveborn piglets	71	70	72	69	70	67	0.56
Number of liveborn piglets per litter	11.8	11.7	12.0	11.5	11.7	11.2	0.12
Number of litter piglets at weaning (28th day)	10.8	11.2	11.1	10.9	11.2	10.8	0.08
Piglets losses in the period 1-28 days of life, %	8.47^{a}	4.27^{bc}	7.50^{a}	5.22^{b}	4.27^{bc}	3.57^{c}	1.23
Body weight of piglets: – at birth, kg	1.46	1.45	1.43	1.44	1.44	1.42	0.02
– at weaning, kg	6.61^{b}	7.27^{a}	6.75^{b}	6.91^{ab}	7.15^{a}	7.19^{a}	0.23
– on 56 day of life, kg	14.54^{b}	16.72^{a}	14.87^{b}	15.16^{b}	16.32^{a}	16.91^{a}	0.54
Daily weight gains – 1-28 days, g	184^{b}	208^{a}	190^{b}	195^{ab}	204^{a}	206^{a}	12.4
Daily weight gains – 29-56 days, g	283^{b}	338^{a}	290^{b}	295^{b}	328^{a}	347^{a}	21.6
Feed intake during suckling period, g/day/piglet	242	238	240	246	250	239	6.3
Feed intake during 28-56 days of life, g/day/piglet	784	788	774	786	776	769	18.4

Explanation: a, b – values in the same rows with different letters differ significantly at $p \leq 0.05$

Tab. 3. Biochemical indices in blood plasma of piglets

	Day of life	Feeding groups						SEM
		I – NC	II – AGP	III – LGP-1	IV – LGP-2	V – LGP-5	VI – LGP-10	
Protein, g l^{-1}	28	58.2	59.4	58.8	58.7	59.0	58.9	0.04
	56	61.8	62.1	61.9	62.0	61.8	62.1	0.09
BUN, mmol l^{-1}	28	5.92	5.71	5.86	5.87	5.79	5.77	0.05
	56	6.11^{a}	5.47^{b}	5.78^{ab}	5.73^{ab}	5.59^{b}	5.51^{b}	0.08
Glucose, mmol l^{-1}	28	4.97	5.03	4.99	5.02	5.05	5.01	0.02
	56	4.82	5.02	4.91	4.93	4.92	4.94	0.03
Total cholesterol, mmol l^{-1}	28	2.31	2.32	2.26	2.21	2.18	2.17	0.09
	56	2.37^{a}	2.33^{a}	2.27^{a}	2.11^{ab}	2.02^{b}	1.97^{b}	0.11
HDL-cholesterol, % of total cholesterol	28	42.4	42.3	42.5	42.5	42.8	43.0	0.12
	56	41.6	41.9	41.7	42.4	42.8	42.1	0.15
Triglycerides, mmol l^{-1}	28	0.78	0.79	0.76	0.77	0.76	0.76	0.02
	56	0.79^{b}	0.81^{b}	0.77^{ab}	0.72^{a}	0.70^{a}	0.69^{a}	0.04

Explanation: as in tab. 2.

groups I (NC), II (AGP) and V (5 g LGP/kg), VI (10 g LGP/kg). Probably 1-2 g LPG additive and its active components were in too small quantity and applied for too short time to show their cholesterolemic effect in piglets. The analysis of HDL cholesterol share indicated a required tendency in cholesterol metabolism under garlic preparation. There was noted a slightly higher HDL cholesterol and regarding a decreased level of total cholesterol, some positive changes in cholesterol metabolism under garlic influence should be emphasized. Recently it has been observed that garlic extracts or garlic powder containing various sulfur compounds effectively decreased the plasma concentration of cholesterol, resulting possibly from the inhibition of the hepatic cholesterol synthesis (26). Garlic depressed the hepatic activities of lipogenic and cholesterogenic enzymes, such as malic enzyme, fatty acid synthase, glucose-6 phosphate dehydrogenase and 3-hydroxy-3-methyl-glutaryl-CoA (HMG CoA) reductase (8, 26). Garlic also increased the cholesterol excretion, as manifested by enhanced excretion of acidic and neutral steroids after garlic feeding (5). Protective effect of garlic on atherosclerosis has been attributed to its capacity to reduce blood lipid content. Alike, in these investigations a marked decline of TGL level was noted in blood plasma of piglets aged 56 days supplied with dietary LGP additive at dose of 2, 5 or 10 g/kg mixture (tab. 3).

Conclusions

Powder from lyophilized garlic clover (LGP) additive, especially in 5 or 10 g/kg mixture, may constitute a recommended dietary component for raising piglets up to 56 days of life. This procedure, an alternative for AGP use, improves body weight gains, decreases piglets losses as well as triglycerides and total cholesterol concentration in blood plasma.

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