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Effect of the application of sage (*Salvia officinalis L*) as a phytogenic additive in rabbit feed

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Abstract: The purpose of the experiment was to determine the effect of the addition of dried ground whole leaves of the herb *Salvia officinalis L* in the feed for fattening rabbits, on the productive parameters, some blood indicators and carcass characteristics. The inclusion of ground dry leaves of the herb sage in feed for fattening rabbits has a positive effect on productive performance. In the experimental group were improved average daily gain by 29,2% (P<0,05), feed conversion ratio by 19% (P<0,05) for the entire experimental period and average daily feed consumption by 3,8% (P<0,05) during the first week of the experiment compared to the control.The tested additive did not reliably affect the parameters of the slaughter analysis, the chemical analysis of the meat and blood parameters.

Keywords: rabbits; *Salvia officinalis L*.; growth performance; carcass traits; blood analyses

INTRODUCTION

The modern consumer is more and more interested in healthy nutrition. Rabbit meat has high dietary properties. For this reason, it is recommended for children, pregnant women and people with high blood pressure. Rabbit meat is an excellent source of minerals and trace elements, such as potassium, calcium, phosphorus, and selenium and has the highest concentration of iron in any type of meat. It is rich in vitamins, mainly vitamin B3, B6, B12 and E, and in Omega-3 and six fatty acids. Another advantage of rabbit meat is its low sodium level. It also contains easily digestible proteins, with low amounts of cholesterol and fat. Even though rabbit meat naturally offers a remarkable nutritious quality, the dietary fortification of rabbits with bioactive compounds has been an increasing trend in recent years, and rabbit meat is becoming a functional food with its superior nutritional properties (Pogány Simonová et al., 2022). Biologically active substances of natural origin are herbs, spices, their extracts and essential oils (Frankič et al., 2009; Grigorova et al., 2017). Sage (*Salvia officinalis L*.) is a herb whose leaves contain a wide variety of bioactive substances, such as the monoterpenes (eucalyptol; alpha-thujone, betathujone, camphor and boronneol) (Saracila et al., 2020) and phenolic compounds (sinapinic acid; p-coumaric acid; ferulic acid; hesperidin; isorhamnetin; catechin; rutin; quercetin) (Saleh et al., 2021). The different types of sage extracts possess antioxidant, anti-inflammatory, antimicrobial, hypoglycemic and antimutagenic bioactivity (Szaboova et al., 2008). It was found that thanks to its useful ingredients this herb improve growth performance (Zaccarato et al., 2011; Rotolo et al., 2013), blood parameters and carcass characteristics (El-Bolkiny et al., 2022) in rabbits. Several studies have tested the effect of adding sage extract to the drinking water of rabbits and a number of positive effects have been observed. The authors reported that aqueous leaves extract of sage plant improved significantly the final body weight, average daily gain, feed conversion ratio (El-Bolkiny et al., 2022)

and feed intake (Szaboova et al., 2008), as well as hematological parameters (El-Bolkiny et al., 2022). Other studies have examined the effect of including dried, ground whole leaves of the herb sage in feed. The additive had a beneficial impact on all zootechnical indicators in rabbits (Zaccarato et al., 2011 and Rotolo et al., 2013) and broilers (Asheg et al., 2014; Farhadi et al., 2020). Furthermore, improved haematological (Al-Sherify and Al-Alwany, 2016), biochemical and immunological parameters (Farhadi et al., 2020) were observed in broilers.

The purpose of the experiment was to determine the effect of the addition of dried ground whole leaves of the herb *Salvia officinalis L* in the feed for fattening rabbits, on the productive parameters, some blood indicators and the slaughter characteristics of the carcass of rabbits of the California breed.

MATERIAL AND METHODS

For the experiment, 30 rabbits were used, divided into two groups for a period of 28 days until reaching a slaughter weight of 2,5 kg. Each group includes 15 rabbits equated by age, breed, sex and live weight. Rabbits were housed in individual cages with dimensions of 600/400/350 mm. Constant access to water was provided via nipple drinkers. Feeding is carried out ad libitum with pelleted compound feed for fattening rabbits with content of crude protein-14,256%, crude fiber-13,429%, fat-1,826%, ME=-1979,62 Kcal/kg. The feed for group I (control) was prepared without a phytogenic additive. For the II experimental group, forage contains 1,5% dried ground leaves of the herb sage (*Salvia officinalis L*).

During the experiment feed intake and body weights of rabbits were recorded individually every week. From these data, average daily gain, average daily feed consumption and feed conversion ratio were calculated. The health status of the animals was monitored daily.

At the end of the experiment, blood samples were taken from v. Saphena of 6 rabbits per group. The analysis of hematological parameters was performed with a 5-Part-Diff Automated Hematology Analyzer URIT-5160. Biochemical parameters total cholesterol, glucose, ASAT (aspartate aminotransferase), ALT (alanine aminotransferase) were determined by using semi-automatic biochemical analyzer Bio Systems BTS-350.

At the end of the trail, six rabbits per group were selected and slaughtered for carcass analysis. The procedure involved severing the carotid artery, jugular vein, trachea and oesophagus. The slaughtered rabbits were bled, and then the skin, genitals, urinary bladder, gastrointestinal tract, and the distal part of legs were removed. Live weight before slaughter (g), warm carcass weight (g), cold carcass weight, weight of skin and legs to carpal and tarsal joints (g), weight of inedible viscera (g), weight of edible viscera (liver, kidney, lung, heart, spleen, g) were determined. From them, the dressing percent was calculated. The weight of the left hind thigh and thigh bones was determined. Bone weight is expressed as part of the thigh. A chemical analysis of the meat of the left thigh and m. Longissimus dorsi (m. LD) was performed, as protein by the Kjeldahl method, fat by the Soxhlet extraction apparatus, ash by combustion in a muffle furnace.

All experimental procedures were carried out in accordance with the requirements of animal welfare of Bulgarian food safety agency.

The obtained results were statistically processed by usual variation statistics methods MS Excel 2010. The difference between groups was analysed by t-test of Student.

RESULTS AND DISCUSSION

Average daily feed consumption is presented in Table 1. The amount of feed received by the experimental group was higher, compared to the control group during all stages of the experiment. The differences are statistically proven at the end of the first week. In the experimental group, this indicator is 3,8% higher than the control group ($P<0,05$).

Table 2 shows that the live weights of the rabbits in the two groups were within a similar range

and there were no significant differences between the groups.

The average daily gain (Table 3) of the animals of the experimental group was higher than that of the control group, with a statistically significant difference of 29,2% (P<0.05) for the whole experimental period.

In the experimental group, a significant decrease in feed conversion rate was observed for the second week of the experiment, the difference

Table 1. Average daily feed intake, g

Item	Control group	Experimental group
At the end of I week	152,72±6,76*	158,46±6,88*
At the end of II week	180,80±12,96	186,52±9,00
At the end of III week	164,86±20,82	174,34±11,31
At the end of IV week	152,91±15,00	156,57±7,50
For the whole trial period	162,82±11,64	168,97±6,65

**P<0,05*

Table 2. Live body weight of rabbits, g

Item	Control group	Experimental group
At the begging of the trail	1946,40±141,06	1924,80±167,66
At the end of I week	2064,10±151,94	2083,00±161,50
At the end of II week	2238,60±186,85	2317,60±162,85
At the end of III week	2399,60±187,98	2528,60±181,24
At the end of IV week	2548,40±180,02	2690,80±193,19

Table 3. Average daily gain of rabbits, g

Item	Control group	Experimental group
At the end of I week	16,81±5,32	22,60±6,46
At the end of II week	24,93±9,08	32,34±9,62
At the end of III week	23,00±7,16	30,14±7,08
At the end of IV week	21,26±7,75	23,17±6,18
For the whole trial period	21,18±2,94*	27,36±4,76*

**P<0,05*

Table 4. Feed conversion ratio

Item	Control group	Experimental group
At the end of I week	10,01±3,37	7,59±2,39
At the end of II week	7,35±1,70*	5,71±1,23*
At the end of III week	7,18±2,63	5,81±1,09
At the end of IV week	7,19±2,27	6,61±1,15
For the whole trial period	7,80±1,08*	6,32±0,99*

with the control group was 28,7% (P<0,05). The tendency to improve this parameter is maintained throughout the entire trial period. For the whole period the differences between the groups was 19% (P<0,05) (Table 4).

This data are in big agreement with Zaccarato et al. (2011) and Rotolo et al. (2013)**,** who reported that inclusion of dried sage leaves, had beneficial effect on all zootechnical parameters of rabbits. When this herb is used in form of extract in drinking water the results are controversially, especialy for feed consumption. According to Szabóová et al. (2008), *S. officinalis* extract positively influence growth performance and feed intake. In other study is shown that there is no effect on productive parameters (Szabóová et al., 2012), whereas Pogány Simonová et al. (2022) established that the rabbits' growth was not significantly influenced by the additive, but feed conversion was lower. On the other hend, El-Bolkiny et al. (2022) report that aqueous leaves extract of sage plant improved significantly the final body weight, average daily gain, feed conversion ratio and significantly decreased the feed and water intake. From the data presented, it can be seen that the addition of dry sage leaves to the forage has a strong positive effect on feed consumption. This effect is proven in three independent experiments (ours, Zaccarato et al., 2011 and Rotolo et al., 2013). A positive influence on consumption is probably due to the improved taste and aroma of the feed by the herb. As we know, herbs and their essential oils improve the aroma and the taste of forages, thereby increasing feed consumption, which in turn leads to improved growth and utilization (Zeng et al., 2015).

Carcass analysis (Table 5) and chemical analysis (Table 6) of the meat revealed similar values of the parameters studied. The only significant difference was in the crude ash content of the hind leg meat, which was 34,5% higher in the experimental group, compared to the control group (P<0,01). In agreement with our study, other studies also confirmed the lack of effect of sage supplementation on slaughter parameters and meat chemical composition (Rotolo et al., 2013; Pogány Simonová et al., 2022). In contrast El-Bolkiny et al, (2022), reported that sage extract in drinking water increase carcass weight, weight of liver, heart, testes and spleen.

From the data characterizing the hematological and biochemical parameters of the blood (Ta-

Table 5. Carcass analysis

Item	Control group	Experimental group
Live body weight, g	2618,67±76,02	2651,67±83,30
Hot carcass weight, g	1614,33±48,90	1661,00±72,59
Dressing percent, %	61,66±1,14	62,63±1,13
Cold carcass weight, g	1584,33±43,24	1639,33±69,20
Left thigh with bones, g	218,67±12,75	217,67±8,14
Bones % of thigh	15,37±2,76	14,40±1,03
Liver, g	70,19±10,45	66,99±6,27
Lung, g	14,02±1,21	13,86±3,06
Heart, g	8,06±1,11	7,86±0,85
Kidneys, g	14,64±1,70	13,69±1,18
Spleen, g	1,87±0,70	1,82±0,41
Feet and fur, g	441,50±44,36	451,83±15,66
Not edible parts, g	364,83±33,64	373,00±47,07

ble 7), a significant difference was found in the mean cell volume, as it was 6,1% higher in the experimental group, compared to the control group (P<0,05). However, all blood indicators were within reference values for the species (http://www.medirabbit.com; MSD Manuals). In contrast with our findings, El-Bolkiny et al. (2022) established that sage extract inclusion in water of APRI rabbits improve hematological parameters hemoglobin (Hgb), red blood cells (RBC), packed

Table 6. Physico-chemical analysis of thigh meat and m. Longissimus dorsi

Item		Control group	Experimental group
Protein, %	Thigh	22,55±0,47	22,69±0,58
	m. LD	23,23±0,77	23,50±0,33
Fat, %	Thigh	1,38±0,43	1,52±0,81
	m. LD	0,92±1,02	1,06±0,52
Ash, %	Thigh	1,13±0,06**	1,52±0,02**
	m. LD	1,16±0,18	1,04±0,16
Ph at 24h post mortem	Thigh	5,92±0,10	5,82±0,06
	m. LD	5,77±0,06	5,77±0,07

***P<0,01*

Table 7. Blood analisis

Item	Control group	Experimental group
Hematological parameters		
WBC, $*10^9$/L	7,92±2,15	7,04±2,67
Lymphocytes, %	49,72±9,22	52,27±6,71
Monocytes, %	14,83±7,20	10,68±4,09
Neutrophils, %	33,78±10,68	36,06±7,88
Eosinophils, %	1,62±0,76	0,92±0,59
Basophils, %	0,05±0,04	0,07±0,07
RBC, $*10^{12}$/L	5,05±1,67	5,58±0,43
Hgb, g/L	93,00±25,48	108,88±8,11
HCT, %	28,35±9,05	33,38±2,56
MCV, fl	56,50±2,32*	59,93±2,44*
Platelets, $*10^9$/L	175,17±90,24	193,00±120,45
MPV, fl	5,72±0,38	5,94±0,60
Blood biochemical parameters		
Glucose, mg/dL	143,63±98,19	121,06±22,00
Total cholesterol, mg/dL	10,36±2,72	10,03±1.40
ALT, IU/L	140,67±67,40	157,83±109,64
AST, IU/L	123,40 ±57,08	89,40±26,80

**P<0,05*

cell volume (PCV), white blood cells (WBC), mean cell hemoglobin concentration (MCHC), but mean cell volume (MCV) and mean cell hemoglobin (MCH) was decrease. A stimulatory effect on haematopoiesis from sage treatment has also been observed in other studies. Al-Sherify and Al-Alwany (2016) reported that the addition of sage leaves powder in broiler chickens diet led to a significant improvement of red blood cell count, PCV concentration and haemoglobin. In mice hydroalcoholic extract of garden sage increased significantly red blood cells and averages of hematocrit (HCT) and haemoglobin (Safari and Modaresi, 2015). Even in fish, an improvement in hematological parameters was observed when an extract of the herb was included in the feed (Dadras et al., 2019).

All animals were in good health throughout the experimental period and no mortality was observed.

CONCLUSIONS

The inclusion of 1,5% ground dried leaves of the herb *Salvia officinalis L* in feed for fattening rabbits has a positive effect on performance. Statistically significantly improved parameters were average daily gain, average daily feed intake and feed conversion ratio. The tested additive did not affect the parameters of the slaughter analysis and the chemical analysis of the meat, with the exception of the crude ash content of the hind leg meat. The values for the blood parameters, established at the end of the experiment, which are within the reference range for the species, indicate that the researched additive does not negatively affect the health status of the animals.

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