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CONTENT

INTORDUCTION

The beginning of year 2021 continues with the rapid spread of the virus SARAS-CoV-2. The pandemic of COVID-19 is still a reason for a change in social life on a global level and a serious cause of the global crisis in all areas of our life.

As the world was adapting to this situation, many factories and warehouses were forced to close, the production in many industries declined, state borders were closed. As other branches of the industry were slowing down, the production and manufacturing of food and drugs continued to work with full force. Social distancing was instigated, and thus, became the new normal. This social distancing era did not affect science and education, as they continued with the help of online platforms and the commodities that today's technology has to offer.

In these times of global economic crisis and a viral pandemic, the key role of science, was once again proven. Science is in the front lines in fight against the pandemic with innovation of vaccines, created by traditional or biotechnological methods, which are used for mass global immunization against the SARAS-CoV-2 virus. The world will remember the beginning of 2021 for start of vaccination of humans with a positive result, followed by expected decline of infected people and control the pandemic. The fact that science is the solution to numerous important problems in human life may once again be an ultimate truth. The mid of 2021 will be a memorable one for the known decline of infected people and control over the pandemic.

The agricultural industry did not go unaffected by COVID-19. Restrictions of movement, as well as basic aversion behavior by workers, may impede farmers from farming and food processors - who handle the vast majority of agricultural products - from processing. Shortage of fertilizers, veterinary medicines and other input could affect agricultural production. Closures of restaurants and less frequent grocery shopping diminish demand for fresh produce and fisheries products, affecting producers and suppliers. However, besides all the hardships that were brought along with the crisis did not halt the agricultural industry and food production kept on developing and functioning in order to meet the demands.

Journal of Agriculture and Plant Sciences Vol. 19, No. 1 is published in the period of mass immunization of humans for the SARS-CoV-2. The continuous publication of the journal in time of the pandemic proves that science and scientific research are of profound importance to agriculture and food processing and production, and must not be held down, even when the world faces a pandemic.

JAPS Editorial board were given a great responsibility, to sustain the continuity of published volumes of the journal in these difficult times of a pandemic and an economic crisis. Therefore, with great honor and respect, we would like to present the latest scientific achievements in agriculture.

Editorial Board, **Editor in chief,**

June, 2021 **Prof. Liljana Koleva Gudeva, PhD**

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Original scientific paper

CHEMICAL CHARASTERISTIC OF RABBIT HIBRIDS

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Abstract

The aim and purpose of the analysis was to evaluate the influence of the gender male/female on the chemical, microbiological and sensory composition. Flemish giant rabbit and New Zealand white rabbits (group ON), were used as a material for the study. Rabbits were fed *ad libitum* with commercial pelleted feed, with the addition of small amounts of green feed and hay. The experiment included 6 rabbits, 3 males and 3 females. Previously defined live weight of 1800 to 2500 g was achieved within 77 days and after that they were slaughtered. This paper provides the conducted results of the research in regard of the chemical, microbiological and sensory composition of the rabbit meat.

The average composition (n-6) of the inclusion of the water in the thigh, shoulder blade and the back are 71.89% / 74.51% / 72.61%, the inclusion of proteins is 19.46% / 18.62% / 21.28%, the inclusion of fats is 3.34% / 4.36% / 2.46%, the inclusion of minerals is 1.16% / 1.10% / 1.19%. In meat parts, are not found bacteria of the following types: *Clostridium*, *Staphylococcus*, *Proteus*, *Escherichia*. The average microbiological content (24 hours *post mortem*) of total bacteria (*bacillus*) number varies from 2.44 to 2. 58 (log CFU/g). Male rabbits are tougher, with more intensive color, taste and smell.

Keywords: *rabbits, hybrids, chemical, microbiological and sensory composition*

INTRODUCTION

Meat represents concentrated source of nutritive composition (Higgs, 2000). Meat used to be declared as product which is optimally crucial for healthy growth of the humans. That knowledge is not respected that well lately, especially in regard to the reduction of the composition of fats. The overuse of meat products with high composition of fats, may lead towards many diseases (hypertension, cancer, diabetes). In regard to this matter it is very important to choose meat without fats i.e. meat with proper composition (Perc, 2001).

Rabbit meat is a reliable source of essential fats and amino acids, protein with high biological value, vitamins from B group (B_{12}) and many other minerals (especially the composition of calcium, copper and iron) (Koch & Pavčič, 2000; Para et al. 2015). The meat also contains very little composition of sodium, fats and cholesterol, very little composition of connective tissue, very easy decomposable in the organism, with sweet taste and it has less energetic value than other types of meat. Regarding all these characteristics and small energetic values, rabbit meat is declared to be protective food for the human heart (Grün, 2002; Lah, 2006).

The chemical content of different parts of

the meat depends on the gender, age, genotype and the type of the meat. This is the reason why there are many deviations between the data from different authors for the chemical content of different types of meat. One of the factors that influence the content and deposition of the fats is the gender. Males grow more intensively and gain more weight in opposition to the females (Andronikov et al. 2019). Due to this fact the meat from the females contains more fat than the male meat (Suchý, 2002). As a result of rabbits being slaughtered very young, before they reach puberty, there are not many significant statistical differences between the genders. For differences to be determined, 15 chemical, microbiological and sensory features of different parts of the rabbit`s body.

weeks of age have to pass (105 days) (Hernández & Lozano, 2001).

Because of the vast necessity of rabbit`s meat in the world, we can expect more expansion of the production of this meat (Skandro et al. 2008). Unfortunately, in Republic of North Macedonia the breeding of rabbits is not developed yet and they are bred on more intensive way and there is no tradition of the consummation of the meat as it is the case in Western Europe where there are immense farms for breeding rabbits and there is a tradition of the meat consuming.

However, the aim of this research is to point out how the gender influences the

MATERIAL AND METHODS

Six rabbit's hybrids (3 male and 3 female), that is, crossed units from the so-called Belgium oriash and New Zealand's white rabbits (ON) fed ad libitum with industrially pelleted food (containing alfalfa, barley, corn, wheat, soy, granules sunflower premixes, salt, vitamins and minerals) were the research material for our study (Andronikov et al. 2019).

The rabbits reached the defined weight from 1800 to 2500 g in 77 days kept in separate wire cages. 24 hours before slaughter, their feeding was stopped. Slaughtering and primary processing of rabbits was performed in the usual way. The slaughter was done after the veterinary examination and looting. 24 post mortem cool carcasses were cut in basic pieces and measured on an electronic scale, there in each organ individually, and then cut to the front, the middle and the back part (Bivolarski et al. 2011).

Chemical analyses

Total nitrogen (TN) was determined according to the Kjeldahl method. Moisture content was determined by drying at 103 ± 2°C to constant mass. The intramuscular fat content was determined according to AOAC International method, with petroleum ether as solvent. Ash was determined by burning and combustion (4 – 5 h) at 525 – 550°C [Ash of Meat, 1997]. Content of sodium chloride was determined by ISO 1841-1/1999. Content of nitrite were determined by ISO 2918- 1/1999.

Microbiological analysis

Following bacteria were determined: Total bacteria (bacillus) number – ISO 4833/2003. Sown on nutrient agar to 37°C during 24 hours. Staphylococcus ISO 6888-1/1999. Sown on ETGP agar (barit parker agar) after termostating on 37°C during 24 hours. Enterobacteriaceae ISO 21528- 1/2004; ISO 21528-2/2009. Escherichia coli are sown on lactose bujon and brilliant green, thermostated on 37°C during 24–48 hours. Clostridium sown on sulfite agar, thermostated on 37°C during 24–48 hours. Data were transformed into log10 CFU/g before comparison of means. The results were statistically processed using mathematical program Microsoft EXEL ANOVA (single factor) 2009/2013.

Sensory examination

The sensory analysis was done by five experienced specialists. The meat of the thigh of a rabbit was previously cut into cubes. Thus, prepared meat was placed separately in pots and thermally treated at a temperature of 72 to 85° C (cooking) without the addition of salt and spices. The analyzed sensory characteristics of the meat were the following: color, after-taste of rabbit flavor, smell, mouth feeling, softness, juiciness. The sensory analysis was done by using a 9-level scale approved by VNIMP Moscow.

Statistical analyses were made by using the statistical software SPSS ver. 21 (SPSS Inc, Chicago, IL, 2012).

RESULTS AND DISCUSSION

From table 1 we can notice that the average composition of water on the back of male rabbits is 73.06% and of females is 72.17%. The average content of water on the back with all rabbits is 72.61%.

The composition of the water on the shoulder of the male rabbits is 75.83% and of the female is 73.20%. The average content of water on the shoulder with all co rabbits is 74.51%.

The composition of the water in the thighs of the males is 71.92% and in females is 71.87%. The average content of water in the thighs with all rabbits is 71.89%.

Table 1. Chemical composition (%) in three parts (back, shoulder and thigh) of male and female rabbits

Chemical composition (%)					
		Back			
	Group	Water	Fat	Proteins	Minerals
BS (n-6)	ON	72.61±0.77	3.34±0.52	19.46±0.90	1.19±0.05
Male (n-3)	ON	73.06±0.54	3.04±0.18	20.25±0.46	1.20±0.03
Female (n-3)	ON	72.17±0.75	3.64±0.59	18.68±0.21	1.17±0.07
		Shoulder			
	Group	Water	Fat	Proteins	Minerals
BS (n-6)	ON	74.51±1.51	4.36±0.25	18.62±0.33	1.10±0.05
Male (n-3)	ON	75.83±0.40	4.24±0.08	18.55±0.43	1.11±0.06
Female (n-3)	ON	73.20±0.73	4.49±0.31	18.70±0.23	1.10±0.04
		Thigh			
	Group	Water	Fat	Proteins	Minerals
BS (n-6)	ON	71.89±0.60	2.46±0.25	21.28±0.61	1.16±0.04
Male (n-3)	ON	71.92±0.79	2.42±0.15	21.72±0.58	1.19±0.03
Female (n-3)	ON	71.87±0.46	2.50±0.35	20.84±0.15	1.14±0.03

$\dot{x}$ – mean, Sd – standard deviation; number of pieces = 3

The fats contents on the back of the males are 3.04 % and in females 3.64%. The average content of fats on the back with all rabbits is 3.34%. The content of fats on the shoulder of males is 4.24% and in females 4.49%. The average content of fats on the back with all rabbits is 4.36%. The fats contents in the thigh of males are 2.42% and in females 2.50%. The average content of fats in the thighs with all rabbits is 2.46%.

The content of proteins on the back of the males is 20.25% and in females is 18.68%. The average content of proteins on the back with all rabbits is 19.46%. The composition of proteins on the shoulder part of the males is 18.55% and in females 18.70%. The average content of proteins on the shoulder with all rabbits is 18.62%. The composition of proteins on the thighs of the males is 21.72% and in females 20.84%. The average content of proteins in the thighs with all rabbits is 21.28%.

The minerals on the back of the males are 1.20% and in females is 1.17%. The average content of minerals on the back with all rabbits is 1.19%. The minerals on the shoulder of the males are 1.11% and in females is 1.10%. The average content of minerals on the shoulder with all rabbits is 1.10%. The minerals on the thighs of the males are 1.19% and in females is 1.14%. The average content of minerals on the thighs with all rabbits is 1.16%.

In our research the composition of the proteins is the highest on the thighs of the males 21.72% and the least is on the shoulder

part of the males 18.55%. The composition of the water is the highest on the rib part of the males 75.83% and the least is on the thighs of the males 71.87%. The content of the fats is the highest on the rib part of the females 4.49% and the least is on the back of the females 2.42%. The composition of the minerals is the highest on the back of the females 1.20% and the least on the rib part of the females 1.10%.

Baiomy & Hassanien (2011) did a research of the chemical content on the meat of New Zealand white rabbits, in which they have conducted the average content of proteins 20.35% (male / female – 20.06% / 20.01%), water (male / female – 69.9% / 70.03%), minerals 0.99 % (male / female – 1.01% / 0.96%), fats 7.87% (male / female – 7.99% / 7.75%).

The results that we have conducted regarding the chemical contents are corresponding with the results that have been conducted by the rest of the authors (Dalle Zotte et al. 1996; Hernández et al. 1998; Gondret et al. 1998; Nizza & Moniello 2000; Metzger et al. 2003; Wood et al. 2003; Pascual et al. 2004; Polak et al. 2006, Ali 2007; Chrenek et al. 2012; Nistor et al. 2013; Belichovska et al. 2017). The mentioned authors determined average composition of water between 60 and 76%, proteins between 18 and 25.0%.

In addition to this, regarding the gender, males have more composition of water, proteins and minerals than females but the composition of fats is bigger in females. Our provided fact corresponds with the results conducted by the other authors (Dalle Zotte et al. 1996; Polak et al. 2006, Ali 2007).

In opposition to this, Baiomy, A.A. & Hassanien H.H.M. (2011) claim that the composition of proteins, fats and minerals in male New Zeland rabbits is bigger than the ones in females.

Table 2. Microbiology (24 h post mortem) (Total bacteria (Bacillus) number) in three parts (back, shoulder and thigh) of male and female rabbits

Microbiology (24 h *post mortem*) (Total bacteria (*Bacillus*) number)				
	Group	Shoulder (log CFU/g)	Back (log CFU/g)	Thigh (log CFU/g)
BS (n-6)	ON	2.44±0.12	2.47±0.17	2.58±0.08
Male (n-3)	ON	2.44±0.06	2.39±0.06	2.56±0.03
Female (n-3)	ON	2.44±0.19	2.55±0.24	2.59±0.13

ẋ – mean, Sd – standard deviation; number of pieces = 3

In meat parts, not found bacteria of the following types: Clostridium, Staphylococcus, Proteus, Escherichia.

Table 2 shows that the back part, the shoulder part and the thighs of the examined rabbits are not contaminated with microorganisms, which leads to the fact that the slaughter and the primary processing of the rabbits is done in strictly prescribed hygienic conditions.

Table 3. Sensory analysis of male and female rabbits.

		Sensory analysis					
	Group	Colour	After-taste of rabbit flavor	Smell	Mouth feeling	Softness	Juiciness
BS	ON	7.90±0.85	7.95±0.89	7.75±0.97	8.40±0.99	7.60±0.75	6.75±0.72
Male	ON	8.30±0.95	8.40±0.97	8.10±1.10	8.30±1.34	7.33±0.88	6.67±0.88
Female	ON	7.56±0.53	7.44±0.53	7.44±0.70	8.44±0.53	7.90±0.48	6.90±0.52

ẋ – mean, Sd – standard deviation; number of pieces = 3

The average sensory values of rabbits are between 6.75 (juiciness) to 8.40 (mouth feeling). The sensory analysis determines that the males have more intensive color, taste and smell in opposition to the females with are softer and juicier.

CONCLUSIONS

Based on results of investigation of chemical, microbiological and sensory characteristics in different parts of meat of Flemish giant rabbit and New Zealand white rabbit, it may be concluded as follows:

Male rabbits in opposition to female rabbits have bigger composition of water, proteins and minerals, meanwhile females have bigger content of fats.

Male rabbits have more intensive color, taste and smell in opposition to the females with are softer and juicier.

No bacteria are found from the following types of Clostridium, Staphylococcus, Proteus, Escherichia. The total number of bacteria (bacillus) showed very low values.

The hygiene conditions in which the course of this experiment was flawless.

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ХЕМИСКИ КАРАКТЕРИСТИКИ НА ЗАЈАЦИ ХИБРИДИ

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Резиме

Влијанието на полот машки/женски на хемискиот, микробиолошкиот и сензорниот состав беа цел на анализа. Како материјал за ова истражување ни послужија хибриди на вкрстени единки од т.н. белгиски оријаши и новозеландски бели зајаци (ОН), кои беа хранети ад либитум со индустриски пелетирана храна. Во истражувањето беа опфатени шест зајаци и тоа три машки и 3 три женски. Дефинираната жива маса од 1800 до 2500 g зајаците ја постигнаа за 77 дена, по што се изврши колењето. Во трудот се изнесени резултатите од истражувањето на хемискиот, микробиолошкиот и сензорниот состав на месото од зајаци. Просечниот удел (n-6) на содржината на вода во бутот, плешката и грбот 71,89% / 74,51% / 72,61%, содржината на протеини 19,46% / 18,62% / 21,28%, содржината на масти 3,34% / 4,36% / 2,46%, содржината на минералните материи 1,16% / 1,10% / 1,19%. Во деловите од месо од зајаци не се пронајдени бактерии од следните родови: *Clostridium*, *Staphylococcus*, *Proteus*, *Escherichia*. Просечниот микробиолошки состав (24 часа post mortem) на вкупниот број на бактерии (*bacillus*) се движи од 2,44 до 2,58 (log CFU/g). Машките зајаци се потврди, со поинтензивна боја, вкус и мирис.

Клучни зборови: *зајаци, хибриди, хемиски, микробиолошки, сензорен состав.*

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WATER PRODUCTIVITY AND EFFICIENCY IN VIOLATED MAIZE IRRIGATION REGIME FOR SILAGE MAIN CULTURE

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Abstract

In the experimental field of the Agricultural Institute, Stara Zagora, on meadow - cinnamon type soil, an experiment with a medium - late maize hybrid Antalya 450 from FAO in case of disturbed irrigation regime was conducted. It was found that the optimally irrigated variant with three irrigations yields an average yield of 1607 kg/dry biomass, which is 20.0% higher than the yield obtained from the non-irrigation variant. With the cancellation of the second irrigation the yield of dry mass decreases by 7.6% compared to the optimal variant, and with the cancellation of the first irrigation the losses of dry biomass reach respectively 12.3% compared to the control variant. The effect of the application of disturbed irrigation regime is highest when canceling the first watering irrigation (K = 0.93) and the lowest values are for the variant with cancellation of the second irrigation (K = 0.57).

Keywords: *maize, irrigation, productivity, dry biomass*

INTRODUCTION

The great potential of corn for high yields, the high energy value of the feed obtained from it, and its easy preservation by silage impose it as a major source of bulky feed for ruminants (Stoycheva, I., 2015). studies for growing corn, with optimal and insufficient security, but they are mainly for grain production (Matev, 2001; Matev et al., 2013; Kalaydzieva and Matev 2011; 2012; Georgieva et al., 2014; Glogova and Nankov, 2006; Stoyanova, 2007; 2009). A number of studies have been conducted with corn for silage under irrigated conditions, but mainly to study the various agrotechnical factors on its productivity (Videva,et al.,1993; Kertikova and Kertikov, 2011;). There is little and insufficient research in connection with the cultivation of silage corn in the conditions of water deficit, which in the coming years will increasingly accompany the cultivation of corn in our country. The aim of the present study is to establish the productivity and efficiency of water in case of disturbed irrigation regime of maize for silage grown as a main crop.

MATERIAL AND METHODS

The study was conducted in the period 2014 - 2016 in the experimental field of the Agricultural Institute, Stara Zagora on meadow - cinnamon soil with medium-late maize hybrid Antalya 450 from FAO. The soil in the experimental field is characterized by the following water - physical properties: FC - 26.57%, coefficient of wilting (KZ) - 18.19%, porosity - 47% and bulk density - 1.45. The tillage and sowing of corn for silage were carried out in the optimal agro-technical term for the region. The application of nitrogen fertilizer was carried out in phase 3 - 5 leaf of the culture. During the vegetation we fought against annual and perennial weeds with the herbicides Mistral Opti 240SK in a dose of 21 ml / da and Casper

55VG in a dose of 30 g / da applied in the culture phase of 3-5 leaves. During the vegetation we performed manual hoeing and shaping of the furrows for irrigation. The study includes the following variants of disturbed irrigation regime: lime.1 Without irrigation - control, lime. 2 Optimal irrigation by three watering cans.3 Irrigation as lime. 2, but with the abolition of the first irrigation.4 Irrigation as lime.2, but with the abolition of the second irrigation.5 Irrigation as lime.2, but with the abolition of the third irrigation. Mathematical processing of the data was performed by software product ANOVA.

RESULTS AND DISCUSSION

The productivity of maize for silage depends both on the agro-technical measures and on the meteorological conditions of the years. Of essential importance for maize is the amount of precipitation that fell during the months of active vegetation (VI - VIII). Figure 1 shows the sum of precipitation by months, years and total for the study period. In terms of rainfall, the months of June and July 2014, which have a significant contribution to the formation of maize yields, are characterized as moderately wet, and August is a wet month, with P&, 47.2%, 33% and 2%, respectively, For 2015 the provision of precipitation for the months of June, July and August is P - 4.7%, 89.8% and 62.4%, ie June is humid, July is dry, and August is an average dry month. For 2016, the month of June is covered by P - 50%, for July - 95% and for August - 90.1%, ie June is wet, and July and August - dry months. During the three experimental years the amount of precipitation was unevenly distributed. Most precipitation in the period May-September fell in 2014 - 385.9 mm and compared to the same months of the multi-year period this amount is higher by 134.2 mm. In 2015, the amount of precipitation was 29.8 mm higher, and in 2016 18.4 mm lower than the average for the multi-year period.

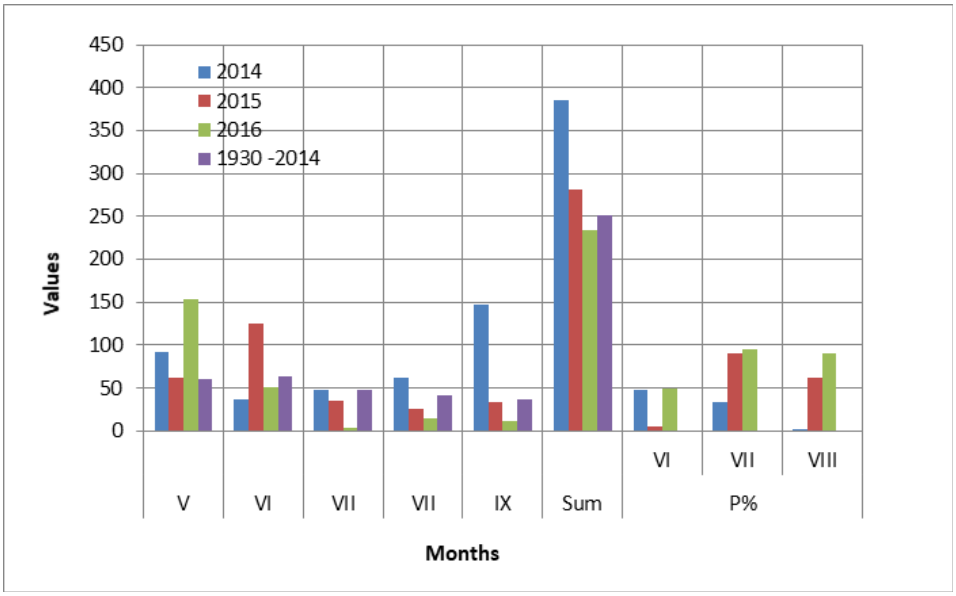

Figure 1. Sum of rains, mm

The sum of the average daily air temperatures during the study years did not differ significantly from those of the multi-year period (Fig. 2)

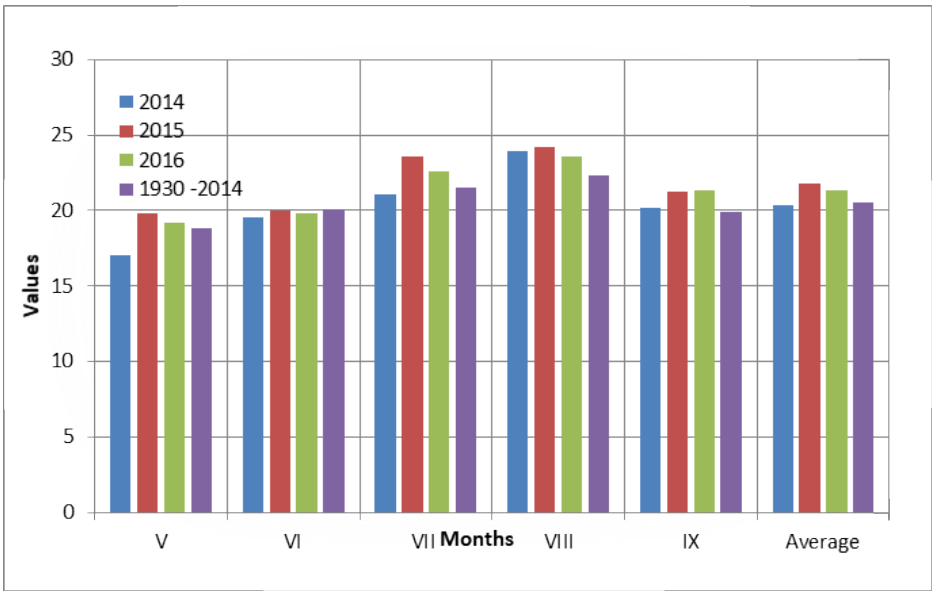

Figure 2 . Sum of the average daily temperature, °C

In determining the effect of the application of the studied variants with the cancellation of irrigation, if it is proved necessary by changing the obtained yield of dry mass compared to the non-irrigated variant, it is established that in lime. 2 (optimal irrigation) the increase of the yield is 20.0% (Table 1) In the variants irrigated together with lime. 2, but with the abolition of irrigation, the largest increase in the amount of yield is observed in option 3 (with the abolition of the first irrigation) - 12.3%. For the variants with cancellation of the second and third irrigation, respectively, the yield increases by 7.6 and 9.1%, respectively, compared to the control variant.

When comparing the yields obtained in the individual variants with the yield obtained from the optimally irrigated variant, it is found that the weakest reduction of the yield from dry mass of corn is in the variant with cancellation of the first irrigation (var.3), respectively - 6.4%. In the variants with cancellation of the second and third irrigation (var.4 and var.5) the yield of dry mass decreased by 10.3% and 9.1%, respectively. The strongest decrease in yield - 16.7% is observed when growing Sudan without irrigation.

When analyzing the productivity indicator per 1 m^3 of irrigation water, it turns out that as the number of irrigations decreases, so does the productive use of water. On average for the vegetation period of corn from one cubic meter of water is obtained from 6.02 to 8.45 kg/da dry biomass. The highest values of this indicator are obtained at lime 3, respectively 8.45 dry biomass. In second place is the option with the abolition of the third watering – lime 5., respectively 8.21. When irrigating maize without a second irrigation (var. 4) the productivity of 1 m3 of irrigation water of the vessel reaches 8.10 kg / da dry biomass. Last in terms of productivity per 1 m3 of water is the optimally irrigated option 2, in which 6.02 kg of dry mass is obtained from each cubic meter of water.

The efficiency of the application of the different irrigation regimes can be expressed by the indicator - coefficient of the irrigation norm K, which represents the ratio between the increase of the yield (compared to the variant without irrigation) and the size of the realized irrigation norm. In case of variation with cancellation of the first watering K is 0.93, i.e. each cubic meter of water provided an additional yield of dry biomass of 930 g.

In the case of optimally irrigated variant 2, the values of the efficiency coefficient of the irrigation norm are 1.00. In case of cancellation irrigation, respectively of the second and third irrigation, the values of the coefficient are 0.57 and 0.69, respectively. each cubic meter of water provided an additional yield of 570 g dry biomass when canceling the second irrigation and 690 g dry biomass when canceling the third irrigation.

Table 1. Efficiency and productivity of irrigation water for 2014 – 2016

Variants	M m^3/da	Yield dry mass kg/ da	+/- yield kg / da compared to var. 1	+/- yield in % compared to var.1	+/– yield in % compared var.2	Productivity of 1m^3 water in kg /m^3	Coefficient of efficiency of the irrigation norm (K).
1.Without irrigation (control)	-	1339	-	100	83,3	-	-
2.Optimalirrigation - three watering	267	1607	268	120.0	100	6.02	1.00
3. With the abolition of the I watering	178	1505	166	112,3	93.6	8.45	0.93
4.With the abolition of the II watering	178	1442	103	107.6	89.7	8.10	0.57
5. With the abolition of the III watering	178	1462	123	109.1	90.9	8.21	0.69
Great differences (GD) % 5%- 3.791 ; 1% -5.182 ; 0.1%- 7.038 kg/da							

CONCLUDING REMARKS

During the study period 2014 - 2016, the optimally irrigated variant with three irrigations yielded an average yield of 1607 kg/da dry mass, which is 20.0% higher than the yield obtained from the variant without irrigation.

With the cancellation of the second irrigation the dry mass yield decreases by 7.6% compared to the optimal variant, and with the cancellation of the first irrigation the losses of dry biomass reach respectively 12.3% compared to the control variant.

The productivity of one cubic meter of irrigation water in the optimally irrigated variant is 6.02 kg / m3. The highest values of this indicator are obtained for the variant with cancellation of the first irrigation - 8.45 kg /m^3

The effect of the application of disturbed irrigation regime is highest in the cancellation of the first irrigation (K = 0.93), and with the lowest values is in the variant with cancellation of the second irrigation (K = 0).

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ПРОДУКТИВНОСТ И ЕФИКАСНОСТ ВО НАРУШЕН РЕЖИМ НА НАВОДНУВАЊЕ НА ПЧЕНКА ЗА СИЛАЖА КАКО ГЛАВНА КУЛТУРА

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Резиме

Во експерименталното поле на Земјоделскиот институт, Стара Загора, на почва од типот на ливада - цимет, беше спроведен експеримент со средно-доцната хибридна пченка *анталија 450* од ФАО со нарушен режим на наводнување. Откриено е дека оптимално наводнуваната варијанта со три наводнувања дава просечен принос од 1607 kg / сува биомаса, што е за 20,0% поголем од приносот добиен од варијантата без наводнување. Со откажувањето на второто наводнување, приносот на сува маса се намалува за 7,6% во споредба со оптималната варијанта, а со откажувањето на првото наводнување загубите на сувата биомаса достигнуваат соодветно 12,3% во споредба со контролната варијанта. Ефектот од примената на нарушен режим за наводнување е најголем при откажување на првото наводнување за наводнување (K = 0,93), а најниските вредности се за варијантата со откажување на второто наводнување (K = 0,57)

Клучни зборови: *пченка, наводнување, продуктивност, сува биомаса.*

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QUALITATIVE FEATURES OF OATS GROWN IN CONDITION OF ORGANIC PRODUCTION

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Abstract

The research was conducted in 2015 and 2016, at 11 oats genotypes in terms of organic production. Three of the studied genotypes were domestic populations: *Krivogashtani*, *Trebenishta* and *Kuchevishte*. The rest were introduced varieties, including *Rajac*, *Slavuj* and *Lovken* from Serbia and *Kupa*, *Baranja, Eksplorer*, *Shampionka* and *Istra* from Croatia.

On average, for both years, the variety *Shampionka* had the highest protein content (14.80%), which indicates that the grain has a high nutritional value. There is a statistically significant difference between the examined genotypes. The percentage of fat in oats, grown organically, in both years of research is statistically different at different genotypes. On average, in both years of research, the fat content ranged from 2.31% in the population*Trebenishta*, up to 4.47% in the population of *Krivogashtani*. The variety *Baranja* is with the highest ash content in the grains (4,35%) in average, for the period of research. In the same group **a**, is ranked variety *Shampionka*, with 4.30%. Between genotypes there is a statistically significant difference. For the period 2015-2016, all examined genotypes belong to group **a**, that is, all varieties and populations contain high cellulose content. Given that the property cellulose content is negatively correlated with the quality of oats, in plant selection, varieties with lower cellulose content are more important. Analysis of variance for the quality of oats grain shows that the content of protein, fat and ash values are relatively constant in the years of the research. The conditions in the years of research had a weaker effect than the genotype. The strength of the genotype is 65.06%, 67.06% and 72.04%, respectively. The properties content of protein, fat and ash are strongly influenced by the genotype while the cellulose content is strongly influenced by the year.

Keywords: *variety, population, proteins, fats, ash, cellulose*

INTRODUCTION

Oat (*Avena sativa* L.) is one of the oldest cereal crops grown as a stand-alone crop due to its high commercial qualities. It has a high protein content, with balanced amino acid composition (Moudry,1992; Nikolic et al., 1989; Спасова, 2008), unlike other cereals, a favorable relationship between nutritional properties and high digestibility, which make oats an indispensable concentrated fodder in the diet of domestic animals.

The agricultural relevance of oats is due to the quality of the grain and the low demands on cultivation conditions, so it can work well in areas where other cereals produce low yields (Spasojevic et al., 1984). With the development of the food industry and the growing need for healthy and dietary foods, the importance of oats for people's balanced nutrition has increased. The oats breeding tends towards the creation of higher yielding varieties, but also requires some irreplaceable grain properties in relation to the production of valuable food and nutritional products (Савова, 2007; Георгиев et al., 2003).

Oat grain has features not found in other cereals. These include: high fat content, proteins

with balanced amino acid content (Moudry, 1992, Yeoh and Watson, 1981; Frey and Colville, 1986), fibers with high content of beta gluten (Wood, 1986; Sterbia and Moudry, 2001).

Grain is high in quality protein and therefore in the food industry a range of easily digestible products of high nutritional value, such as oat flakes, semolina, oat flour is produced from the oat grains (Antonova et al. 2000).

Many authors examine the content of these valuable constituents in the oat grain and conclude that the content varies with the variety and conditions of crop cultivation (Saastomoinen et al., 2004; Yeoh and Watson, 1981; Sterbia and Mourdy, 2001).

Oats are one of the most suitable cereals for organic production (Spasojevic et al., 1984). This is consistent with studies of other authors (Lockeretz et l., 1981) that examining varieties of oats in terms of organic production, discovered that oats is very suitable cereal for organic production, considering the high yields they have received, which ranged from 4 to 5 t / ha.

The aim of our research was examining the chemical properties of oat grain in terms of organic production, which would allow to determine the importance of varieties in human nutrition and their recommendation in modern culinary and food technology.

MATERIAL AND METHODS

Field trials were set up on the experimental field of Faculty of Agriculture, University "Goce Delchev", in Strumica, during 2015 and 2016, and laboratory examinations were performed in the laboratories of the Faculty of Agriculture.

Eleven oat genotypes were analyzed. Three of the populations were domestic: *Krivogashtani*, *Trebenishta* and *Kuchevishte*. The rest introduced varieties were from abroad, including *Rajac*, *Slavuj* and *Lovken* from Serbia and varieties: *Kupa*, *Baranja, Eksplorer*, *Shampionka* and *Istra* from Croatia.

The experiments were set up in three repetitions, arranged by the random block system method, with its basic parcel of 5m^2.

The distance between the variants was 0,50 m, and between repetitions 1 m. The distance between rows was 20cm. Seed rate of 550 grains per 1m^2 was used. Basic soil tillage was performed at a depth of 35 cm. Prior to sowing, additional processing and fertilization with 30 t/ha biofertilizer was performed, in accordance with the organic production regulations.

Prior to harvest, 1m^2 material was taken from each plot for laboratory analysis, to analyze the chemical properties of oat grains that determine grain quality. The chemical properties of the grain were determined by the following methods:

- **Cellulose:** Intermediate Filtration Method (ISO 6865: 2000). Animal feed - Determination of raw fiber content;
- **Protein:** Cereals and legumes - Determination of nitrogen content and calculation of crude protein content according to the Kjeldahl method (ISO 20483: 2006);
- **Ash:** Cereals, legumes and by-products - Determination of ash content by incineration (ISO 2171: 2007);
- **Fat:** Animal feed - Determination of fat content (MKS ISO 6492: 2012).

Statistical analysis of the results was performed by the method of variance analysis and Principal Component Analysis, using the JMP programme.

RESULTS AND DISCUSSION

Protein content

Oat grain is rich in high quality protein and therefore in the food industry a range of easily digestible products with high nutritional value, such as oat flakes, semolina, oat flour is produced (Antonova et al. 2000).

Among the constituent components of oats, protein concentration is often ranked as the highest because of its importance in the diet.

On average, for the two years, the variety *Shampionka* has the highest protein content (14.80%), indicating that the grain is of high nutritional value (Tab. 1). There was a statistically significant difference between the examined genotypes.

Fat content

Oat grains have more favourable fat composition than other cereals, since most triglycerides in fatty acids consist of oleic and linoleic acids. Oat grains are relatively rich in fat than other cereals and can vary from 3% to 11% by weight of different varieties, with lines containing up to 18% fat (Frey and Holland, 1999).

Among genotypes, the variance, in average for the test period is higher. The coefficient of variation (Tab. 1) is 19.37%. Compared with the CV% of other properties it becomes clear that only in fat the percent of variation is more severe.

On average, for the two years, the variety *Krivogashtani* has the highest fat content (4.47%), indicating that the grain is of high nutritional value (Tab. 1). The results of our examinations match the examinations of Frey and Holland, 1999. There was a statistically significant difference between the analyzed genotypes.

Ash content

Oat grain in terms of dry matter, on average, contains 10-13% protein, 58-65% starch, 4.2 - 5.5% fat, 11.6 - 14% raw fiber, 1.4 - 2% sugar and 3.2–3.8% ash (Pospišil, 2010).

Regardless of the year of examination, the best genotype from the analyzed ones, with the highest ash content, showed the variety Baranja, and with the lowest variety Istra.

On average, for the research period, the variety *Baranja* have the highest ash content of 4.35% (Tab. 1). Along with her in the group a is also the variety *Shampionka* with 4.30% ash. There is a statistically significant difference between genotypes.

Cellulose content

The cellulose is located in the fruit and seed layer in the amount of 10.0-11.50%. Its quantity, above all, depends inversely on the size of the grains and the climatic conditions of the area in which it is grown (Василевски, 2004).

On average, for the period 2015-2016, all genotypes studied belonged to group **a**, ie all varieties and populations contain a high content of cellulose (Tab.1). Given that the property cellulose content is negatively correlated with the quality of oats, in plant selection, varieties with lower cellulose content are more important.

Table 1. Chemical composition of oats grown organically for the period 2015-2016.

Varieties / Populations	Protein content (%)	Fat content (%)	Ash content (%)	Cellulose content (%)
Krivogashtani	13.75 ab	**4.47 a**	3.90 ab	14.95 a
Trebenishta	13.25 b	2.31 c	3.90 ab	17.55 a
Kuchevishte	13.50 b	3.65 ab	4.00 ab	21.15 a
Rajac	13.65 b	3.80 ab	3.75 b	**23.15 a**
Slavuj	13.75 ab	3.48 abc	3.95 ab	19.70 a
Lovken	12.85 b	3.53 abc	3.90 ab	21.85 a
Kupa	12.95 b	2.61 bc	3.75 b	19.50 a
Baranja	13.05 b	2.81 bc	**4.35 a**	**3.20 a**
Eksplorer	13.60 b	2.64 bc	3.95 ab	19.85 a
Shampionka	**14.80 a**	3.12 bc	**4.30 a**	17.80 a
Istra	13.65 b	3.23 abc	3.20 c	15.00 a
Mean	13.53	3.23	3.90	19.46
LSD	1.1	1.27	0.52	16.01
CV%	3.69	19.37	6.15	37.42

LSD - Least Significant Difference; **CV** – Coefficient of variance

The analysis of variance for the quality of oat grains in the period 2015-2016 is given in Table 2. Figures show that the properties protein, fat, and ash contents have relatively constant values over the years of research. For them, the conditions of the year had less influence than the genotype. Genotype strength was 65.06%, 67.06% and 72.04%, respectively. The three features were also influenced by the interaction between genotype and the conditions of the year. Interaction ranges from 19.07% in ash content to 27.12% in fat content (Tab. 2). The property, cellulose content, unlike other properties, was strongly influenced by the conditions of the year, with the strength of the year factor being 69.12%. Genotype also influences the content of cellulose (η = 21.64%), while the interaction between the factors year x genotype is low (η = 9.24%).

Table 2. Analyzes of the variance of grain quality in oats for the period 2015-2016.

Properties	Source of variation					
	Genotype		Year		Interaction	
	MS	η	MS	η	MS	η
Protein content	1.618***	65.06	1.559***	12.54	0.557***	22.39
Fat content	2.292***	67.06	0.994***	5.82	0.927***	27.12
Ash content	0.549***	72.40	0.549***	8.53	0.145***	19.07
Cellulose content	45.570***	21.64	759.584***	69.12	20.312***	9.24

MS – mean squares; **η** – effect of factor; *** - P<0,001

In order to get a clearer picture of the general variation between the properties that determine the quality of oat grain, Principle Component Analysis, was performed. The results of the analysis are presented in Table 3 and Figure 1.

In 2015, two main components with eigenvalue higher than 1,00% were separated. The first main component accounts for 48.09% of the total variance, and the second with 27.51% of the total variance.

The cumulative percentage of both components was 75.60% of the total variation. It is relatively high and the model can explain much of the variation in properties.

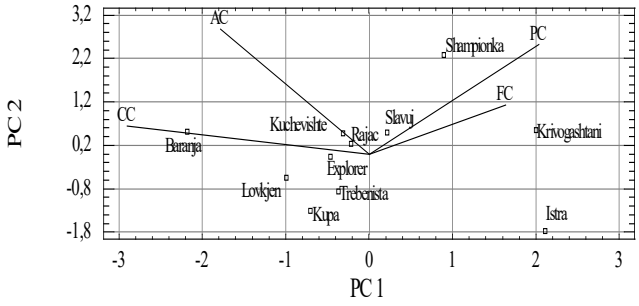
In 2016 there were also two main components with a eigenvalue higher than 1%. The first main component accounts for 41.76% of total variance. The second component has a load limit value of 1.22 and accounts for 30.57% of the total variation of properties.

On the average, for the research period, two main components were also extracted and respectively for the two years, the cumulative percentage of the two components was 70.90% of the total variation (Tab. 3).

Table 3. Component vector analysis of the analyzed properties by years and average for the period 2015-2016.

Main components	2015 year			2016 year			Mean for the period 2015-2016		
	Eigen value	Percent of variability (%)	Cumulative percentage (%)	Eigen value	Percent of variability (%)	Cumulative percentage (%)	Eigen value	Percent of variability (%)	Cumulative percentage (%)
1	1.92	48.09	48.09	1.67	41.76	41.76	1.61	40.21	40.21
2	1.10	27.51	75.60	1.22	30.57	72.33	1.23	30.69	70.90

The Figure 1 shows a grain quality projection of the analyzed oat varieties. The positive quadrant of the projection contains protein and fat content, indicating that there are varieties in the test group with high values. The vectors of these two indicators draw an acute angle, which proves the positive relationship between them. A positive relationship exists with the other two indicators characterizing the quality of the grain - ash content and cellulose content. Their vectors are in the negative quadrant of the plane and show that they are negatively related to protein and fat content and their value depends on the conditions of research. The genotypes *Shampionka*, *Slavuj* and *Krivogashtani* have the best combination of values according to the studied indicators. They are located in the positive part of the plane close to the vectors of protein and fat. *Istra* is also a variety with good quality indicators, but the location in the lower positive quadrant also indicates a dependence on environmental conditions. The greater number of varieties is located close to the cellulose vector, indicating that they have high values for this indicator.



AC – Ash content; **CC** – Cellulose content; **PC** – Protein content; **FC** – Fat content

Figure 1. Projection of quality of oat varieties average for the test period of study.

CONCLUDING REMARKS

Based on two years of research and the results of the chemical composition of oats grown in organic production we can conclude that:

- On average, for the two years, the variety Shampionka has the highest protein content (14.80%), indicating that the grain is of high nutritional value. There was a statistically significant difference between the examined genotypes.
- On average, for the period 2015-2016, the fat content of oats grain is highest in the genotype Krivogashtani (4.47).
- On average, for the research period, the variety Baranja has the highest ash content - 4.35%. Along with it in the group a is also the variety *Shampionka* with 4.30%. There is a statistically significant difference between genotypes.
- On average, for the period 2015-2016, all genotypes studied belong to group a, i.e., all varieties and populations contain high cellulose content. Given that the property cellulose content is negatively correlated with the quality of oats, in plant selection, varieties with lower cellulose content are more important.
- The properties content of protein, fat and ash are strongly influenced by the genotype while the cellulose content is strongly influenced by the year.

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КВАЛИТЕТНИ СВОЈСТВА НА ОВЕСОТ ОДГЛЕДУВАН ВО УСЛОВИ НА ОРГАНСКО ПРОИЗВОДСТВО

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Резиме

Истражувањето е спроведено во 2015 и 2016 година, на 11 генотипови овес во услови на органско производство. Три од испитуваните генотипови се домашни популации: кривогаштани, требеништа и кучевиште. Останатите 8 се интродуирани сорти, и тоа: рајац, славуј и ловќен од Србија и купа, барања, експлорер, шампионка и истра од Хрватска.

Во просек, за двете години од испитувањето, сортата шампионка имаше најголема содржина на протеини (14,80%), што укажува дека зрното има висока хранлива вредност. Постои статистички значајна разлика помеѓу испитуваните генотипови. Процентот на масти во овесот, органски одгледуван, во двете години на истражување е статистички различен кај испитуваните генотипови. Во просек, во двете години на истражување, содржината на масти се движеше од 2,31% кај популацијата требеништа, до 4,47% кај популацијата кривогаштани. Сортата барања е со најголема содржина на пепел во зрната (4,35%) во просек, за периодот на истражување. Во истата група а е рангирана и сортата шампионка, со 4,30% пепел. Помеѓу генотиповите постои статистички значајна разлика. За периодот 2015-2016 година сите испитани генотипови припаѓаат на групата а, односно сите сорти и популации содржат висока содржина на целулоза. Со оглед на тоа дека својството содржина на целулоза е во негативна корелација со квалитетот на овесот, во селекцијата на растенијата, позначајни се сортите со пониска содржина на целулоза. Анализата на варијанса за квалитетот на зрната од овес покажува дека содржината на протеини, маснотии и пепел е релативно константна во текот на годините на истражувањето. Условите во годините на истражување имаа послаб ефект од генотипот. Јачината на генотипот е 65,06%, 67,06% и 72,04%, соодветно. Својствата, содржина на протеини, масти и пепел се под силно влијание на генотипот, додека содржината на целулоза е под силно влијание на влијанието на условите на годината на испитување.

Клучни зборови: *вариетет, популација, протеини, масти, пепел, целулоза.*

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