7th international scientific conference
RURAL DEVELOPMENT 2015
Towards the Transfer of Knowledge, Innovations and Social Progress
19-20 November, 2015, Aleksandras Stulginskis University, Lithuania

Proceedings of the 7th International Scientific Conference Rural Development 2015

Edited by prof. Asta Raupelienė

ISSN 1822-3230 / eISSN 2345-0916
eISBN 978-609-449-092-7

Article DOI: http://doi.org/10.15544/RD.2015.034

MULCHING IMPACT ON THE QUALITY OF OIL PUMPKIN'S (*CUCURBITA PEPO* L.) FRUIT

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Nutritious value of great (*Cucurbita maxima*) and musky (*Cucurbita moschata*) pumpkin pulp has been widely investigated, but chemical and qualitative analysis of pulp of oil pumpkin fruits has been superficial so far. The aim of two years research – to investigate the influence of compost/organic mulch to the quality of organically grown oil seed pumpkin (*Cucurbita pepo*) fruit quality. In 2013–2014, in Kaunas district farm, oil seed pumpkins cultivars 'Heracles', 'Hamlet', 'Danaja' were grown for research. The aim of two years research – to investigate the influence of compost/organic mulch to the quality of organically grown oil seed pumpkin fruit. Pumpkin seedlings were mulched with 5 and 10 cm thick layer of compost mulch. Standard methods were applied to identify the following: dry matter, soluble dry matter, crude protein, crude fibre and amounts of MADF, NDF, ADF fibre and crude in the pumpkin flesh. The results have determined that 5 and 10 cm compost mulch layer had a significant effect on the amount of dry matter in the pumpkin flesh. Basically, mulching has increased the amount of soluble dry matter in the pumpkin flesh. Crude protein accumulation in the fruit flesh was essentially affected by 5 cm thick layer of compost. Mulching with 5 and 10 cm compost layer has significantly increased the amount of crude fibre in 'Hamlet' and 'Heracles' cultivars. 5 and 10 cm compost mulch had a significant effect on the amount of crude ash. According to the researched indicators set parameters in ecologic system of the researched oil-seed pumpkins, the best cultivator to be grown with organic mulching is 'Hamlet'.

Keywords: chemical content, quality, organic mulch, oil seed pumpkins.

INTRODUCTION

More and more Lithuanian farmers choose organic growing of vegetables. This method reduces the usage of chemicals in agriculture, negative effect on the soil and creates an alternative for a healthy lifestyle. One of the ways to better domesticate soil and to increase crop yield is mulching. Mulching as a weed control method is used in agriculture throughout the world (Gupta, 1991). Since weed seed germination is affected by soil moisture and temperature, mulch not only suppresses weeds, but also maintains soil moisture at higher levels compared with unmulched soil (Edwards et al., 2000). According to literary data, soil mulching reduces the evaporation of moisture, regulates soil temperature, improves its structure and increases organic matter stocks, stimulates biochemical processes, improves plant nutrition (Wyenandt et al., 2008; Splawski, 2012,; Raupp, 2002).

In Lithuania the most often grown pumpkins of *Cucurbita maxima* D. and *Cucurbita pepo* L. varieties which are resistant to cool weather and fruits ripe successfully. Pumpkins are valuable not only for their nutritional and healing properties but also for their simple growing technology. They produce one of the highest yields in comparison with other vegetables.

The nutritional value of pumpkin fruits is high, but varies depending on the species and cultivars. The flesh of pumpkins fruits is tasty and valuable vegetable containing a lot of biologically active materials and distinguished for dietary qualities. Pumpkins contain a lot of mineral materials, vitamins, particularly vitamin A provitamin β-carotene, ascorbic acid, vitamins B_1, B_2, B_6, E. They are rich in carbohydrates, particularly in starch and sugars. Amount of sugars in pumpkins strongly depends on climatic conditions; average amount is 5–6 %. Pumpkins have low calorific value; their energetical value fluctuates from 15 to 39 kcal (Juknevičienė et al., 2013; Nawirska-Olszańska, 2011; Oloyede et al., 2012).

Oil seeds pumpkins *Cucurbita pepo* are valued for their naked seeds used to produce oil. These pumpkins can be used as a food and in medicine, seeds are perfect material for oil production. In Lithuania oil seeds pumpkins is commonly

grown not only for oil seeds but and for flesh for fruit crops. Many people use pumpkin oil as a healthy and tasty food additive. Nutritious value of great (*Cucurbita maxima*) and musky (*Cucurbita moschata*) pumpkin pulp has been widely investigated, but chemical and qualitative analysis of pulp of oil pumpkin fruits has been superficial so far. The aim of two years research – to investigate the influence of compost/organic mulch to the quality of organically grown oil seed pumpkin fruit quality.

MATERIAL AND METHODS

In 2013–2014, in Lithuania farm, oil seed pumpkins cultivars 'Heracles', 'Hamlet', 'Danaja' were grown for research. Soil of experimental location – quite neutral, of high humus content, limnoglace clay loam on the boulder clay, carbonate, deeply gleyic luvisol, on the average phosphorus and potassium (Tab. 1). In the experimental plot the soil was drained with drainage.

Table 1. Characteristics of soil conditions in the field used in the experiment

pH_{KCl}	Humus content (%)	P_2O_5 (mg kg^{-1})	K_2O (mg kg^{-1})
7.1	3.08	262	164

Sprouts of oil pumpkins were planted in 2.0 × 2.0 m fields at 1.5 m distance in the third decade of May. Width of protective belt – 1 m. The size of the recorded field – 6.25 m^2. 5 and 10 cm compost mulch was spread after the seedlings (with one real leaf) had established and the plants germed the third leaf. The area around the seedling covered with mulch – 0.5 m, i.e. 1 m in diameter. Composition of compost: 9% peat and 91% crop leftover. Chemical content of compost used for fertilization: total nitrogen 135 mg/l, total phosphorus 68 mg/l, total potassium 193 mg l^{-1}. Carbon and nitrogen ratio C:N – 20. Fruits were harvested at the end of September. The experiment was repeated three times.

Chemical oil-seed pumpkin's analysis were conducted in the chemistry laboratories of Food raw materials, agronomical and zoo-technical investigations, LUA; laboratory of food technologies, department of Horticulture LUA; One month until the beginning of research, the harvest was kept at 10–15 ºC temperature with 60–65 % relative humidity. 3 oil-seed pumpkins' fruits were taken from each repetition for research of which a laboratory sample of at least 1 kg was taken. Standard methods were applied to identify the following in the oil-seed pumpkins: dry matter (LST ISO 751:2000), soluble dry matter (LST ISO 2173:2004), crude protein (LST 1523:1998), crude ash (Januškevičius, Mikulionienė, 2004) the amounts of fiber components analyses: crude, modified solution (MADF) (cellulose, lignin, heat damaged protein), acid detergent fiber (ADF) (cellulose, lignin) and neutral detergent fiber (NDF) (cellulose, hemicellulose, lignin) using cell wall detergent fractionation (Methodenbuch–VDLUFA 1983–1999).

The experimental data was statistically processed by the dispersion analysis method (ANOVA), software STATISTIKA 7.0 (StatSoft, USA). Dispersion analysis was applied to evaluate chemical composition of field pumpkin fruit. Arithmetical means and standard errors of the experimental data were calculated. Turkey test ($p<0.05$) estimated statistical reliability of mean differences.

RESULTS AND DISCUSSION

Amount of dry matter – is one of the most important chemical content quality indicators, ensuring the quality and output of the recycled products. Depending on the type and cultivator, the amount of the above mentioned substances in pumpkin's flesh can fluctuate from 5.6 to 16 % (Loy, 2004). Pumpkins that are grown in Lithuania can accumulate 4.1–24.14 % of dry matter (Danilcenko et al., 2011). Having evaluated mulching influence to the accumulation of dry matter in pumpkin's flesh, it was established that mulching basically increased the amount of dry matter. Research results have shown that accumulation of dry matter was mostly stimulated by 10 cm mulch (Table 2).

Table 2. Mulching influence to the content of dry matter in oil-seed pumpkin's cvs. flesh, % d.m.

Cultivar	Without mulch	5 cm mulch	10 cm mulch
'Herakles'	$7.32\pm0.05^{b*}$	8.16 ± 0.04^{a}	8.59 ± 0.02^{a}
'Hamlet'	6.10 ± 0.07^{c}	6.88 ± 0.05^{b}	9.15 ± 0.05^{a}
'Danaja'	6.84 ± 0.02^{c}	7.66 ± 0.05^{b}	7.84 ± 0.04^{a}

*– The different letters in the same column and row show significant differences between means ($p<0.05$)

Soluble dry matter is an important indicator for chemical evaluation of pumpkin raw material. This matter has impact on the sensual properties of the recycled products. The amount of compounds of such matter in the pumpkin's flesh increases during storage (Roura et al., 2004). During different years of research, the amount of dry matter in the fruit flesh of pumpkins that were grown in Lithuania varies from 1.58 to 11.85 % (Danilcenko et al., 2011). Mulching with organic mulch had unequal impact on the amount of soluble dry matter in pumpkins. Actually, its major amount was determined in 'Heracles' pumpkin flesh – from 5.25 to 5.90 %. 10 cm mulch influenced the amount of soluble dry matter in all fruits of researched pumpkins' cultivators (Table 3).

Proteins are very easily absorbed and it is the main "construction material" of human body's cells. The organism uses the structural protein for constructing cells and their organoids. If the body does not get a sufficient quantity of

proteins for quite a long, certain physiological functions of the body malfunction, body weight decreases, enzyme synthesis weakens (Ekpedeme et al., 2000).

Table 3. Mulching influence to the content of soluble dry matter in oil-seed pumpkin's cvs. flesh, % d.m.

Cultivar	Wihout mulch	5 cm mulch	10 cm mulch
'Herakles'	5.25±0.05^{b}	5.46±0.04^{a}	5.90±0.02^{a}
'Hamlet'	3.40±0.07^{c}	3.46±0.05^{b}	4.20±0.05^{a}
'Danaja'	4.10±0.02^{c}	4.35±0.05^{b}	4.70±0.04^{a}

*– The different letters in the same column and row show significant differences between means ($p<0.05$)

Crude protein in the flesh of researched pumpkins varied from 1.02 to 1.97 % (Table 4). According to the results, genetic traits of the cultivator had a significant influence to the amount of crude proteins because their considerably greater amount was accumulated in the flesh of 'Hamlet' pumpkins: in a control variant without mulch – 1.84 %, with 5 cm layer of mulch – 1.97 % and 10 cm – 1.93 %. In the flesh of 'Heracles' pumpkins, when they were grown with 5 cm layer of mulch, 1.38 times higher amount of crude protein was identified in comparison with the same without mulching (Table 4).

Table 4. Mulching influence to the content of crude protein in oil-seed pumpkin's cvs. flesh, % d.m.

Cultivar	Wihout mulch	5 cm mulch	10 cm mulch
'Herakles'	1.02±0.05^{c}	1.41±0.04^{a}	1.30±0.02^{b}
'Hamlet'	1.84±0.07^{b}	1.97±0.05^{a}	1.93±0.05^{a}
'Danaja'	1.61±0.02^{b}	1.81±0.05^{a}	1.61±0.04^{b}

*– The different letters in the same column and row show significant differences between means ($p<0.05$)

In pumpkins it is identified a significant amount of fibre which has a positive physiological effect: stimulates intestinal peristalsis, absorbs toxins, disease-causing bacteria, provides a favourable environment for the development of intestinal micro flora. Food which is rich in fibre is valuable for obesity prevention. It was determined that the amount of fibre in the flesh of researched pumpkins was varied (Table 5). Most crude fibre was found in "Hamlet" pumpkin flesh – 2.17%. Used mulching had a positive effect on its accumulation in all pumpkins cultivators in comparison with a control. Substantial increase in the amount of crude fibre content was identified in 'Hamlet' pumpkin flesh when 10 cm mulch was used in agricultural equipment. In comparison with the plants that were not mulched, its amount increased 1.2 times (Table 5).

Table 5. Mulching influence to the content of crude fiber in oil-seed pumpkin's cvs. flesh, % d.m.

Cultivar	Without mulch	5 cm mulch	10 cm mulch
Crude fiber			
'Herakles'	1.94±0.05^{b}	2.01±0.04^{a}	2.04±0.02^{a}
'Hamlet'	1.80±0.07^{c}	1.88±0.05^{b}	2.17±0.05^{a}
'Danaja'	1.89±0.02^{a}	1.96±0.05^{a}	1.82±0.04^{b}
NDF fiber			
'Herakles'	19.11±0.34^{bc}	18.90±0.26^{c}	19.22±0.13^{bc}
'Hamlet'	19.46±0.22^{b}	19.51±0.11^{b}	19.62±0.31^{b}
'Danaja'	26.41±0.29^{a}	26.14±0.17^{a}	26.75±0.25^{a}
ADF fiber			
'Herakles'	18.26±0.18^{cd}	18.12±0.09^{d}	18.52±0.13^{c}
'Hamlet'	16.51±0.12^{e}	16.38±0.22^{e}	16.55±0.16^{e}
'Danaja'	24.02±0.08^{b}	24.52±0.26^{a}	24.56±0.11^{a}
MADF fiber			
'Herakles'	18.41±0.19^{b}	18.47±0.25^{b}	18.75±0.25^{b}
'Hamlet'	15.11±0.23^{c}	15.30±0.12^{c}	15.34±0.09^{c}
'Danaja'	23.38±0.15^{b}	23.15±0.12^{b}	23.78±0.22^{a}

*– The different letters in the same column and row of different kind of fiber show significant differences between means ($p<0.05$)

When assessing the nutritional value of products and forage, not only crude fibre is determined but also two fibre fractions – MADF, consisting of cellulose, lignin, heat damaged (denatured) protein and NDF fibre, which contains the matter of all cell wall structures. It is also identified the fibre (ADF) leached with acid solutions. Value and properties of dietary fiber depends on the relative proportion of its various fractions. An important interaction is the one between different components of fiber and other materials – proteins, oligosaccharides, lipides, mineral materials (Nawirska et al., 2008; Nawirska, Uklańska, 2008). Also types, amount and composition of fiber depend on the type, cultivar and physiological maturity of pumpkin fruit. According to A. Nawirska (2008), the NDF fiber content in C. pepo pumpkin flesh ranges 0.23–4.37 % fresh matter, C. maxima pumpkin – 1.20–4.37 % fresh matter., ADF fiber – respectively 0.22–0.47 % fresh matter and 0.43–1.46 % fresh matter.

In the flesh of the researched pumpkins, the amount of MADF, NDF and ADF fibre respectively ranged from 15.11–23.78 %, 18.90–26.75 % and 16.0–24.56 % (Table 5). Basically, the greater amount of all the researched fibre was established in 'Danaja' pumpkin flesh and minimal amount of MADF and ADF fibre was found in 'Hamlet' pumpkin flesh.

A considerable increase of all the researched fibre fractions was recorded in the pumpkins' flesh when 10 cm mulch was used in agricultural equipment.

Ash – mineral nutrients, which perform different functions in plant and human life. For the functioning of human body, the amount of mineral nutrients obtained together with food must be sufficient because otherwise even a slight lack of it can affect the compound metabolism. According to literary data, from 0.24 to 1.48 % (in dry matter) of ash are found in the flesh of pumpkins (Konopacka et al., 2010; Nawirska-Olszańska et al., 2011). The results have shown that the amount of crude ash in the flesh of oil-seed pumpkins was from 0.48 to 1.00 % (Table 6). It was identified, that on the average, most of it was accumulated in 'Danaja' flesh when 5 and 10 cm mulch was used for plants – respectively 0.98 and 1.00 %. Basically, a minimal amount of crude ash was established in 'Hamlet' fruit flesh: without mulch – 0.48 % and with 5 cm mulch – 0.51 %. From the received data it can be claimed mulch had no significant impact on the amount of crude ash, it was mostly due to a variety of genetic traits (Table 6).

Table 6. Mulching influence to the content of crude ash in oil-seed pumpkin's cvs. flesh, % d.m.

Cultivar	Without mulch	5 cm mulch	10 cm mulch
'Herakles'	0.61 ± 0.05^{b}	0.72 ± 0.04^{a}	0.63 ± 0.02^{b}
'Hamlet'	0.48 ± 0.07^{c}	0.51 ± 0.05^{b}	0.72 ± 0.05^{a}
'Danaja'	0.73 ± 0.02^{b}	0.98 ± 0.05^{a}	1.00 ± 0.04^{a}

*– The different letters in the same column and row show significant differences between means ($p<0.05$)

CONCLUSIONS

Having summarized the research results it can be claimed that basically mulching increased the amount of dry matter in the flesh of oil-seed pumpkins. Used 10 cm mulch stimulated the accumulation of soluble dry matter and MADF, NDF and ADF fibre. Organic mulch has a significant impact on the accumulation of crude fibre in the flesh of all the researched pumpkin cultivators. Crude protein accumulation in the fruit flesh was essentially affected by 5 cm thick layer of compost. Mulching with 5 and 10 cm compost layer has significantly increased the amount of crude fibre in 'Hamlet' and 'Heracles' cultivars. 5 and 10 cm compost mulch had a significant effect on the amount of crude ash. According to the researched indicators set parameters in ecologic system of the researched oil-seed pumpkins, the best cultivator to be grown with organic mulching is 'Hamlet'.

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