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EVALUATING OF SELECTED PARAMETERS OF COMPOSTING PROCESS BY COMPOSTING OF GRAPE POMACE

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Abstract

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In Europe, there is annually available 8 million tons of grape pomace. From the viewpoint of waste management, pomace represents biotic waste produced in the FDM (Food–Drink–Milk) sector. Composting process represents an effective use of grape pomace. Introduced experiment deals with monitoring of the composting process of grape pomace provided by 2 different variants of different composition of composting piles. Obtained results indicate that dynamics of process is affected by the share of raw materials. According to the temperature curve characteristics, the temperature above 45 ^{0}C for at least 5 days was necessary for compost sanitation. Such temperature was achieved in piles with higher proportion of pomace (Var.II). Analysis of results shows that the compost made of grape pomace is a quality organic fertilizer, which may have in addition to agronomic point of view also great hygienic and ecological importance.

compost, composting, grape pomace

The grapevine is recently the most grown fruit species and the area of vineyards reaches about 7.9 million hectares, about 4.5 million hectares are located in Europe (approximately 57%). According to estimates of the Organisation Internetionale de la Vignet et du Vin (OIV, 2009), there are 66.5 million tons of wine grapes annually processed worldwide, of which 38 million tons of grapes are processed in Europe. About 8 million tons of grape pomace is yearly available in Europe.

Pomace is a residue composed of pulp, skins, seeds, and grape stems, representing approximately a quarter of the grapes mass. Also RAGAN (2002), PLÍVA, KOLLÁROVÁ, MAREŠOVÁ (2010) claim, that the share of pomace represents 15–25% of the total quantity of processed grapes (of the density of 400–800 kg.m^{-3}) depending on the variety, degree of ripeness, used pressing equipment, number of pressing cycles, etc. Moisture after pressing is around 20–30%. The ratio of carbon and nitrogen in fresh pomace ranges between ration of 40–45:1. Pomace pH, according to variety and ripeness ranges from 3 to 6. Pomace itself has a granular structure and it has a good suction ability.

From the perspective of waste management, pomace is a biotic waste produced in the FDM (Food–Drink–Milk) sector. According to the latest principles of waste management, applied in the EU, the non-waste technologies are primarily sought. Attention is being focused also at the possibility of effective use of grape pomace as a secondary product for the production of compost in the last few years.

Direct application of pomace on the surface and subsequent cultivation of the soil is not proper. The main obstacles are: the long time of decomposition due to unfavorable ratio of C:N, an insignificant effect of improving of the soil conditions. These obstacles can be partially eliminated by pomace application on the soil together with nitrogen and phosphatic fertilizers.

Effective utilization of grape pomace as a waste product is a process of aerobic biodegradation of organic matter by microbial activity, e.g. the composting process (FISCHER, BEFFA, LYON, ARAGNO, 1998). During such process, complex organic compounds such as carbohydrates, proteins, etc. to simpler inorganic compounds are gradually decomposed. Some of the substances are oxidized up to CO_2 and H_2O during the process. The main principle of composting is not the complete decomposition of input components, but preparation of biologically stable material, which will not become a subject of further rapid decomposition or undesirable rotting processes (RYNK *et al.*, 1992; EPSTEIN, 1997).

Requirement for successful composting is finding suitable proportion of raw materials, so called compost recipe. Good conditions for creating and maintaining optimal parameters (temperature, humidity, sufficient aeration, pH etc.) must follow in order to reach adequate increase of microorganisms during the composting process (PLÍVA, KOLLÁROVÁ, MAREŠOVÁ, 2010).

DIAZ, BERTOLDI, BIDLINGMAIER (2007) state, that the process of composting of grape pomace is negatively affected by a relatively high proportion of dry vine seeds, which in addition to fiber (12–15%) and fat (13–14%) contain also acids and oils, which restrict the activity of microorganisms and excessively prolong the time, necessary for decomposition.

The aim of this experiment was a semi industrial evaluation of composting process of grape pomace, resulting from grapes processing as a non–waste technology leading to environmental burdens reduction and producing high quality organic fertilizer.

MATERIAL AND METHODS

Compost piles establishment and its composition

Three variants of compost piles with different proportion of grape pomace were prepared as indicated in the Table I.

The composition of compost piles primarily met the requirements of different structural properties of the resulting mixture and availability of material at location of experiment. During experiment establishment, volumes of individual types of raw materials as well as density of components were monitored.

When individual components of compost piles were heaped up, final shapes of piles were provided by loader UNC–060 to desired width of the base of 2.4 m and top width of 1.5 m. Piles were of trapezoidal profile with slightly varying heights ranging from 1.0 to 1.1 m and the total length of 15 m. Turning of compost was performed by tractor trailed, rotor–windrow turner PKS 2.8 aggregated with the tractor Zetor 7211.

Monitoring and evaluation of the temperature course

The temperature was measured by thermometer SANDBERGER GTH 1150 always in identical location. Temperature measurements were taken weekly in the center of profile, in the depths of 0.25, 0.50 and 0.75 m from the top.

Parameters of the SANDBERGER GTH 1150 thermometer are as follows:

- Type: GTH 1150
- Measuring range: from –50 to 1 150 °C
- Measurement accuracy: from –20 to 550 °C < 1% ± 1
- Length of probe 800 mm.

Monitoring of moisture

Humidity of compost was scanned at a depth of 0.5 m from the top of the pile by sensor VIRRIB. Sensors, located in each pile were connected to the recording device VIRRIBLOGGER. When moisture dropped under 40%, moisture was increased by watering.

Parameters of the VIRRIB are as follows:

- Power: 5.5–18 V=
- Output: 0–5 mA, 0–2.5 V, (or other, on request)
- Measuring range: 5–50% volumetric of moisture
- Measuring accuracy: less than 0.01 $m^3.m^{-3}$.

After the composting process finished, moisture was measured by gravimetric method.

Analysis of nutrients

Nutrient analysis was done according to the industry standard ČSN 46 5735 for compost and in accordance with the regulation of the ÚKZÚZ (Central Institute for Supervising and Testing in Agriculture) No. 475/2000 digest. The actual analysis was done by Morgan's analysis for compost because a high number of organic components was present. The point of this method is to analyze mixed samples of weight of 10 g in combination with Gohler's solution sodium acetate (CH_3COONa) and acetic acid ($C_2H_4O_2$) and active charcoal). After components dilution, the solution is analyzed by atomic absorption spectrometer (Ca, Mg, K) and by spectrophotometer (P).

pH monitoring

The compost pH was assessed by potentiometric measurements of pH in the extract of compost mixed with distilled water. A sample of weight of

I: *The ratio of raw materials for experimental compost piles*

Experimental variant	The ratio of raw materials			
	Pomace	Vegetable waste	Wood chips	Livestock manure
Var.I	8	10	6	2
Var.II	12	10	4	2

10 g, over which 50 ml of distilled water was spilled was stirred for 10 minutes by a mechanical stirrer. The pH value was measured in course of one hour at the temperature of 20 ^{0}C. The measurement proceeded every two minutes from the beginning of the measurement and was provided by glass and calomel electrodes located directly in a suspension by suitable pH–meter.

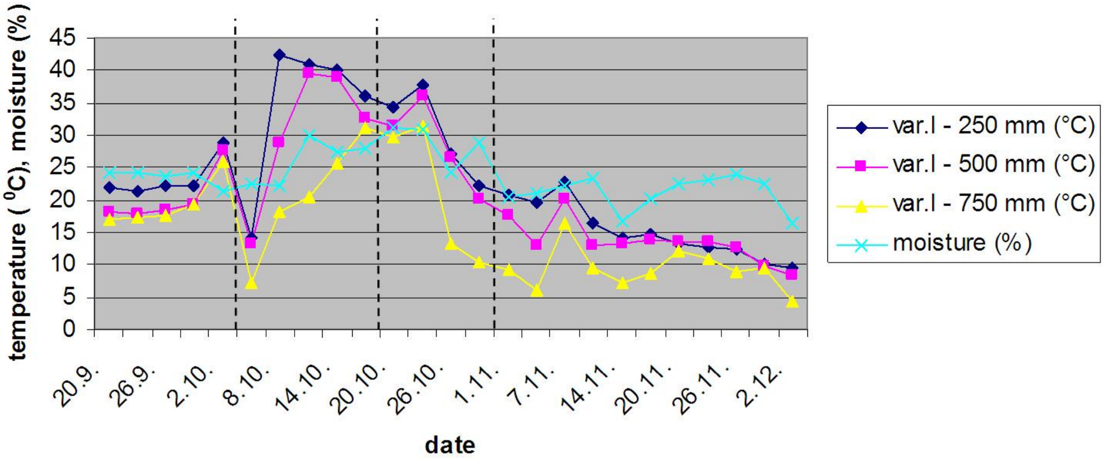
RESULTS AND DISCUSSION

Temperature and humidity monitoring

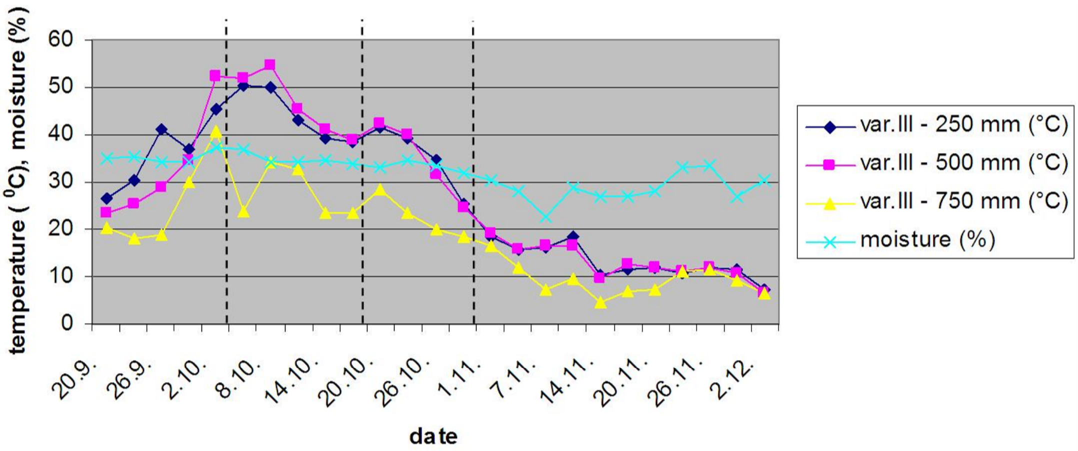
Course of temperature measurements in trial piles with marked turning interference (3 times in each variant) is show in the Chart 1 and Chart 2.

To reach the maximum of temperature is important especially for compost hygienic role. Measured values indicate that in compost piles with greater share of pomace (Var. II) a rapid temperature rise up to the maximum temperature in the range of 42–52 ^{0}C occurs during the first three weeks.

Experimental trial of the Variant I with the highest proportion of structural wood chips and vegetable waste shows relatively slow start of decomposition process, which even after turning interventions remains less intense and relatively slow. This finding is in accordance with general knowledge on slow disintegration of materials with higher proportion of C:N ratio such as wood chips in compost CANET, POMARES (1995), EPSTEIN (1997).



1: *Temperature, humidity and turning interventions for Var. I*



2: *Temperature, humidity and turning interventions for Var. II*

II: *The final values of compost nutrient content and pH*

Experimental variant	Nutrient content (mg.kg^{-1})				N_c (% solids)	$C_{org.}$ (% solids)	pH/KCl	pH/H_2O
	K	Mg	P	Ca				
Var.I	633	86	590	702	1.67	30.24	6.7	7.6
Var.II	451	93	484	818	1.47	31.87	7.0	7.8

Measured values of compost piles moisture show that pomace is a good absorbent material. A larger proportion of grape pomace in compost mixture has a positive effect on maintaining the required moisture. COPPOLA, DUMONTET, MARINO (1983), EPSTEIN (1993) evaluated absorption capacity of different types of raw materials suitable for composting.

In the Table II, there are final values of nutrient content reached in evaluated variants of presented compost mixture

Results of nutrient content analysis prove that compost made with a proportion of grape pomace is a good organic fertilizer, which is an important element in the cycle of matter and nutrients in nature. This was confirmed by the relatively high nitrogen content (1.47–1.67% of dry weight). PAREDES *et al.* (2000), RAGAN (2002) state that compost containing 2.6% nitrogen, 27% carbon, 0.9% phosphorus and 2% potassium can be considered as a "high quality" compost. Similarly MAHIMAIRAJA, BOLAN A HEDLEY (1995) state that the content of nutrients in composts depends on used input materials, of which the compost was produced. Compost with dry matter nitrogen content below 1% is marked as a low quality.

With regard to actual trends of disposal of generated biological waste, compost made of pomace, a byproduct of wine–production, can be used for soil fertility renewal.

CONCLUSION

Presented experiment monitored composting process of pomace in two piles of different composition. The obtained results indicate that the process dynamics was effected by the amount of raw material in the mixture. The temperature curve proved that the temperature, necessary for compost hygienic purpose, e.g. temperature above 45 ^{0}C lasting for minimum of 5 days, was reached in trial piles with higher share of pomace (Var. II).

With regard to the content of nutrients, the compost, made with proportion of grape pomace, represents a quality organic fertilizer. It can have, in addition to agronomic point of view, also great hygienic and ecological importance. Controlled composting of grape pomace together with other raw material can lead to return to great amount of nutrients and organic matter to the soil and simultaneously reduce an amount of waste that would burden the environment.

SUMMARY

From the perspective of waste management, pomace is a biotic waste produced in the FDM (Food–Drink–Milk) sector. According to the latest principles of waste management, applied in the EU, the non-waste technologies are primarily sought. Attention is being focused also at the possibility of effective use of grape pomace as a secondary product for the production of compost in the last few years. Results of nutrient content analysis prove that compost made with a proportion of grape pomace is a good organic fertilizer, which is an important element in the cycle of matter and nutrients in nature. This was confirmed by the relatively high nitrogen content (1.47–1.67% of dry weight). Controlled composting of grape pomace together with other raw material can lead to return to great amount of nutrients and organic matter to the soil and simultaneously reduce an amount of waste that would burden the environment.

The results presented in this paper were obtained within work on the NAAR Project (The National Agency for Agriculture Research Project) No. QH81200 called „Optimization of water regime in landscape and increase of its retention capacity through the application of composts from biologically degradable waste to arable land and permanent grassland", under guidance of the Ministry of Agriculture.

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