

## **PROPERTIES OF THE CARROT GRANULATE INTENDED FOR THE FEEDING OF ANIMALS IN THE ORGANIC FARMING**

### *Summary*

*The study determined the usefulness of dried carrot as a raw material for the production of feed pellet. The influence of relative humidity of ground carrot dried on the hardness, specific density and absorbability of the granulated product was investigated. The results were compared to the hardness, density and absorbability of the dried, unchopped carrot root sections. The relative humidity of the raw material was: 12, 18, 24%. It was found that with increasing relative humidity of raw material from crushed dried carrot, the hardness of the granulate increases and its specific density and absorption coefficient decrease.*

**Key words:** carrots, carrot pellets, feeding of animals

## **WŁAŚCIWOŚCI GRANULATU MARCHWIOWEGO PRZEZNACZONEGO DO SKARMIANIA ZWIERZĄT W GOSPODARSTWIE EKOLOGICZNYM**

### *Streszczenie*

*W pracy określano przydatność suszonej marchwi jako surowca do produkcji granulatu paszowego. Badano wpływ wilgotności względnej rozdrobnionego suszu marchwiowego na twardość, gęstość właściwą i nasiąkliwość wyprodukowanego z niego granulatu. Wyniki porównywano do wartości twardości, gęstości właściwej i nasiąkliwości wysuszonych, nierozdrobnionych odcinków korzenia marchwi. Wilgotność względna surowca wynosiła: 12, 18, 24%. Stwierdzono, że wraz ze zwiększeniem wilgotności względnej surowca z rozdrobnionego suszu z marchwi zwyczajnej następuje wzrost twardości granulatu oraz spadek jego gęstości właściwej i współczynnika nasiąkliwości.*

**Słowa kluczowe:** marchew, granulaty marchwiowy, skarmianie zwierząt

### **1. Introduction**

Carrot roots are an important food product [1]. Carrot (*Daucus carota* L.) is a root vegetable rich in compounds such as carotenoids and dietary fiber. Carrots also contain significant levels of other nutrients such as carbohydrates, proteins and fats and are a good source of vitamin C and elements: Ca, Fe, Na, K, Mg, Cu, Zn [4, 5, 7, 11, 12]. Carrots have a high moisture content (85-90%) and about 10% of raw protein on a dry matter basis, besides it is a highly digestible raw material. Too high percentage of carrots in the diet may cause a coloration of fat in lambs and cattle, therefore the levels of carrot supplement in feed should be limited to 20%. Carrot leaves can accumulate chemical compounds - nitrates, therefore care should be taken when handling residues resulting from carrot production [8].

There is a long tradition of feeding farm animals with carrot, but its use in animal nutrition is currently marginal. Carrot as a feed material comes mainly from the surplus obtained during the periods of overproduction. It is usually served fresh, whole or chopped, often partially gritted [7]. Carrots can also be pickled. Dehydrated carrot is a delicacy for horses and other livestock. Carrot products for feeding animals include also waste from the processing of carrots for juice and dried, which can be used as an addition to feed for livestock. [2, 6]. In a temperate climate, it can be used to feed animals mainly in winter [7]. Drying carrots to feed animals may concern residues from the production of organic carrot juices. It may also apply to carrots, which due to limitations of used plant protection products in organic farming has been infected by pests. Infected carrot that is

unsuitable for trade and can be completely destroyed. Drying it will stop the biological destruction processes and allow storage and use for feeding animals. The preparation of granules from dried carrot will also allow for its precise dosing and addition to feed [9].

### **2. Aim of the tests**

The aim of the research was to determine the effect of relative humidity of dried carrot subject to the granulation process on selected physical properties of the granulate such as: hardness, specific density and absorbability. The aim of the study was also to compare the hardness of the granulate made from dried ground carrot with the hardness of the uncrushed elements of dried carrot.

### **3. Material and methodology of research**

The material for testing included the roots of carrots from organic farming. The raw material was divided into two parts. The first part of carrot roots was cut into sections from 5 to 7 cm, and then it was subject to drying in an oven at 105 °C. This part of the material was a non-ground dried carrot. The second part was ground with a disc mill and then also subject to a drying process. In both cases, the drying process was carried out until the weight of the material after the subsequent inspection stages during drying ceased to fall. Each control of the weight of the dried material was carried out after three hours. It was assumed that the material prepared in this way has, as a result, drying with zero relative humidity. During drying, the relative humidity of

the carrot was determined in the fresh state, which was 81.69%. Relative humidity of tested samples was marked in accordance with PN-EN 14774-1 (2010) [3].

Three groups of raw material were prepared from the crumbled carrot dried material, varying in relation to each other in terms of their relative humidity. These were samples with relative humidity: 12, 18 24%. They were obtained by adding a specific volume of water to the dried material, mixing it with this water and then closing it in an airtight container and leaving it for 72 hours, so that the moisture is evenly distributed in the raw material.

The granulation of the prepared material samples was carried out in a ZSL 150 laboratory granulator, with holes diameter in a matrix of 6 mm. Fig. 1 shows examples of carrot granules and dried carrots from cut root parts. Dried sections of dried carrot, obtained from chopped carrot root parts, were subject to manual edge treatment with a knife to obtain a diameter of the cross-section equal to the diameter of the obtained granulate. The measurement of granulate hardness and dried root sections was carried out using the Kahl tool [10]. The measurement was made for 30 samples from a given material group.



Source: own work / Źródło: opracowanie własne

Fig. 1. View of dried carrot and carrot granulate: a) dried carrot root, b) carrot granules

Rys. 1. Widok suszu i granulatu marchwiowego: a) wysuszony korzeń marchwi, b) granulak marchwiowy

Determination of the specific density of carrot granules was made in accordance with the standard (PN-EN ISO 188472016-11), measuring the height and diameter of 10 granules with an accuracy of  $\pm 0.02$  mm and determining their weight using a laboratory scale with an accuracy of  $\pm 0.001$  g. Relative density of the agglomerate was calculated as the ratio of the total weight of the granulate to the sum of its volume.

The test of the absorption coefficient was determined as the ability of the granules to absorb water at normal atmospheric pressure. The water absorption  $N_w$  was determined as the ratio of the mass of absorbed water to the mass of the dry material sample:

$$N_w = \frac{m_n - m_s}{m_n} \cdot 100\%$$

where:

$N_w$  - absorption coefficient [%],

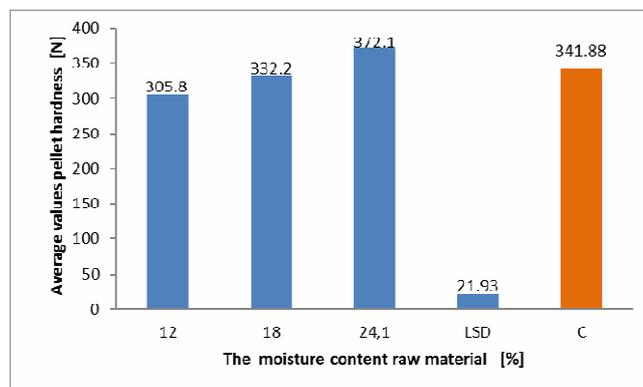
$m_s$  - mass of the sample in the dry state [kg],

$m_n$  - mass of the sample in in the state saturated with water [kg].

The measurement was repeated ten times.

#### 4. Results of the study

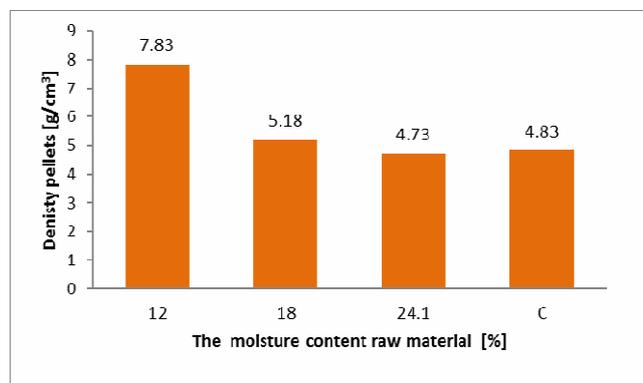
The results of testing the hardness of the granulate made of dried carrot root were subject to the analysis of variance in order to determine the impact of the relative humidity of the raw material on the hardness of the granulate made from it (at the significance level  $p < 0.05$ ). The graph in Fig. 2 shows the effect of relative humidity of the raw material on the granulate hardness and the relationship between the hardness of the granulate made from the ground dried carrot root in relation to the hardness of the dried root elements of the carrot. The value of the smallest significant difference for granulate hardness is marked on the graph. The graph shows the importance of the impact of the moisture content of the raw material on the hardness of the obtained granulate for all the assumed humidity levels. The increase in the relative humidity of the granulate has a positive effect on the increase in hardness. The hardness value of dried whole carrot root elements did not exceed the maximum hardness of the granulate, but it falls within the range of the obtained hardness of the granulate in the tested humidity range. Fig. 3 shows the dependence of the relative humidity of the pellet on the specific density of the granulate from the dried carrot root.



Source: own work / Źródło: opracowanie własne

Fig. 2. Effect of relative humidity of raw carrot raw material on the hardness of the produced granulate, C - dried carrot root

Rys. 2. Wpływ wilgotności względnej surowca z marchwi zwyczajnej na twardość wytworzonego granulatu, C - wysuszony korzeń marchwi



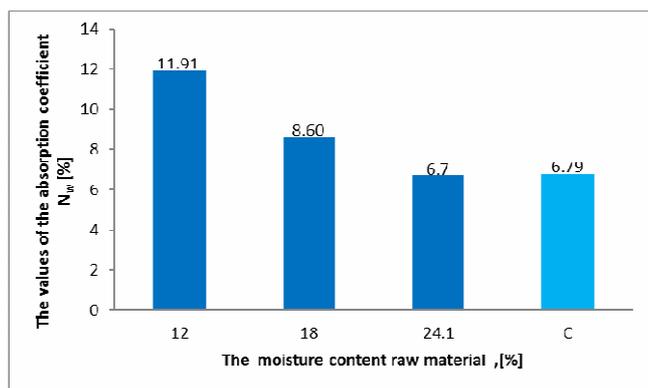
Source: own work / Źródło: opracowanie własne

Fig. 3. Effect of relative humidity of raw carrot raw material on the relative density of the produced granulate, C - dried carrot root

Rys. 3. Wpływ wilgotności względnej surowca z marchwi zwyczajnej na gęstość właściwą granulatu, C - wysuszony korzeń marchwi

Increasing the relative humidity of the raw material caused a decrease in the specific density of the granulate. The lowest value was achieved for the sample obtained from the granulate at a relative humidity of 24.1% - the value of the specific density was 4.73 g/cm<sup>3</sup>. The specific density of the dried carrot root sections was significantly lower than that of the granules in the obtained at 12% moisture of the raw material.

An important parameter is the resistance of the pellet to atmospheric factors, including water absorption, which depends largely on the structure and moisture of the granulate. In the conducted tests, absorbability of pellet samples decreased with increasing humidity.



Source: own work / Źródło: opracowanie własne

Fig. 4. Effect of relative humidity of raw carrot raw material on the value of the absorbability coefficient of the produced N<sub>w</sub> granulate, C - dried carrot root

Rys. 4. Wpływ wilgotności względnej surowca z marchwi zwyczajnej na wartość współczynnika nasiąkliwości N<sub>w</sub> granulatu, C - wysuszony korzeń marchwi

The results obtained on the graph (Fig. 4) show that the highest value of the coefficient was obtained in the case of 12% relative humidity of the carrot. Along with the increase in relative humidity, the value of the absorption index N<sub>w</sub> decreases to the level of 6.7 g/cm<sup>3</sup>, at the relative humidity of 24.1%.

## 5. Summary

On the basis of the conducted research, a significant effect of the humidity of the raw material from ground dried carrot on the hardness of the granulated product was found. The hardness of the granulate increases significantly as the moisture content of the raw material increases. The hardness of the granulate made from ground dried carrot may be

higher than the hardness of the dried, uncrushed carrot root with a similar diameter to the granulate diameter.

The influence of the humidity of the raw material from the ground carrot dried material on the value of the specific density and the absorption coefficient of the granulate made from this dried material was found. The specific density and the water absorption coefficient of the granulate decrease when the moisture content of the raw material increases. The value of the specific density and the absorbability coefficient of the granulate made from ground dried carrot may be higher than the specific density and absorption coefficient of the dried, uncrushed carrot root with a similar diameter to the granulate diameter.

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