POLISH JOURNAL OF FOOD AND NUTRITION SCIENCES

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Pol. J. Food Nutr. Sci.
2007, Vol. 57, No. 2(A), pp. 161-164

NON-PRESSURE GRANULATION OF MUSHROOM POWDER

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Key words: mushroom powder, non-pressure granulation, binding liquids

Food products of substantial grinding are very inconvenient to use both in a household as well as in a technological process. The main disadvantages of such products are dustiness and problems with storage caused by high hygroscopicity and the tendency to cake. The aim of the research was to investigate the usage of non-pressure granulation in the production of agglomerate from dried, powdered mushroom fruiting bodies. For the purpose of the research it was important to evaluate the qualities of the obtained granulate. An important quality feature is the size of the granules formed during the granulation process. In all the combinations tested, granules of over 1.0 mm in diameter were obtained and were always bigger than the test combinations (0.81 mm).

INTRODUCTION

Mushrooms are materials characterised by limited stability when they are fresh. Longer storage requires necessary application of preservation processes. The best method to preserve mushroom fruiting bodies is to dry them using the sublimation method. The advantage of dry products is that they can be powdered [Kawala *et al*., 1993; Łobaszewski *et al*., 1990; Macura, 1994; de Rooij, 1990].

Food products of considerable grinding are very inconvenient to use both under household conditions, as well as in a technological process. The main disadvantages of such products are their dustiness and problems with storage, due to high hygroscopicity and a tendency to cake [Hogekamp *et al*., 1996; Iveson *et al*., 2001; Jetzer *et al*., 1983].

One of the methods that help to avoid such problems is their agglomeration, *i.e.* creation of a product (granulated product) of desired size and shape of particles [Korpal & Weiner, 1998]. For very tiny particles, the best method of agglomeration is non-pressure granulation [Hogekamp *et al*., 1996; Iveson *et al*., 2001; Jetzer *et al*., 1983]. It enables effective acquisition of agglomerates of small granulation and high internal porosity of granules. The equipment for non-pressure granulation is much cheaper than that for pressure granulation. The most economic equipment for non-pressure agglomeration is a plate granulator [Korpal & Weiner, 1998].

The aim of the research was to investigate the usage of non-pressure granulation in the production of agglomerate from dried, powdered mushroom fruiting bodies. Selected binding additives were compared: starch, potato syrup, water (for control tests) on the basis of measurements of basic physical and durability features.

MATERIAL AND METHODS

The research material consisted of dried mushroom fruiting bodies of *Lentinula edodes*. After the material had been dried, it was powdered. The scope of research included: (1) measurement of the physical features of the lyophilizates, *i.e.*: moisture, chute angle, angle of repose, bulk density, shaken density, granulometric distribution on sieves, and average measurements of a particle; (2) non-pressure agglomeration with different binding liquids, *i.e.*: distilled water, potato starch solution, and potato syrup solution; (3) measurement of physical features of granulates, *i.e.*: shaken density, granulometric distribution on sieves, average measurements of granulate, and resistance to compression.

Measurements of the physical properties were carried out according to the binding norms. Resistance to compression was determined using an Instron 4302 apparatus. This device is furnished with an tensometric head with the pressure force of 1 kN; the shift speed of the head was 50 mm/min. Samples were compressed and the maximum force was recorded. The stand for resistance measurements is presented in Figure 1.

Water solution of potato syrup and potato starch (powder diluted in water) was used as a binding liquid, and a control test with water was conducted. The preparation of the solution consisted in diluting a proper amount of potato starch powder in a liter of water and heating it to the temperature of starch mashing, *i.e.* around 70°C. The solution of potato syrup was also prepared by diluting the proper portion of syrup

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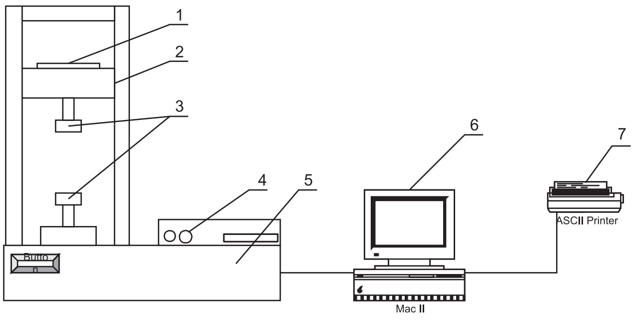

FIGURE 1. The diagram of laboratory equipment to test resistance to compression (1 – measurement head, 2 – beam, 3 – working plates, 4 – steering panel, 5 – Instron 4302, 6 – computer, 7 – printer).

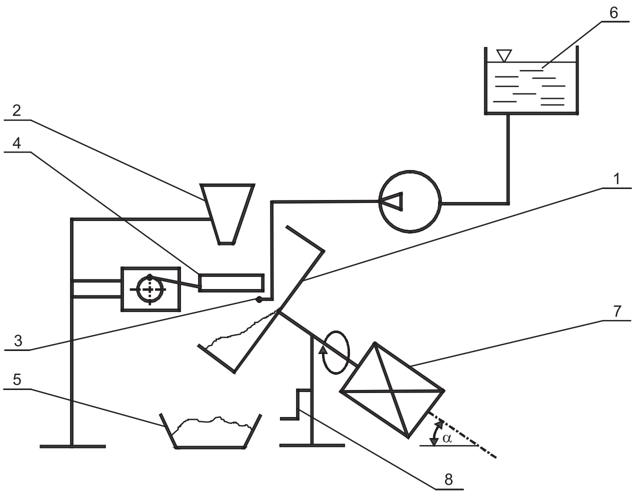

FIGURE 2. Diagram of a stand for non-pressure granulation (1 – granulator plate, 2 – heap, 3 – spraying nozzle, 4 – sieve, 5 – granulate, 6 – binding liquid, 7 – engine, 8 – regulating the angle of plate inclination).

in water at a temperature of 70°C. Due to the application of heaters in the liquid chamber, the temperature of the binding liquid was the same all the time, and reached 70°C. Proportional shares of starch and potato syrup were defined by tests, after performing introductory tests, taking into account liquid viscosity and the ability to spray through the spraying snout of the granulator. The following testing combinations were applied: 5.0% potato starch and 10% solution, 40% and 60% potato syrup, and water as control.

The stand for non-pressure granulation is presented in Figure 2.

RESULTS AND DISCUSSION

A new species of medicinal mushroom, as well as the powder acquired from its fruiting bodies were analysed. The final product was compared with the norm for Standard-Mushroom preserves. The basic values of the physical features of the mushroom powder were evaluated for the usefulness to create new types of food products. In view of its technological usefulness, high shaken density of the mushroom powder is important in comparison with its bulk density. It compares the tendency of powder to cake, as observed during the analysis. The results were compiled in Table 1 for comparison.

The first step of research was to define basic physical features of the material for granulation (Table 1).

As powders have practical application, their important feature is their granulometric distribution. The results indicate that mushroom powder is composed of two groups of fractions: very tiny and tiny – 0.1 mm in diameter, in the amount of 52.3% of the total amount of powder, and the average fraction with particles of 0.2 to 0.5 mm in diameter, found in the amount of 42.4% of the tested material. Particles of over 0.5 mm in diameter were found in the amount of around 5.6% (Figure 3).

The average particle size of the tested material was 0.22 mm. The measurements of the physical features of the material indicate a strong tendency to cover and cake (high shaken density in comparison with bulk density), which is a disadvantage of this type of material.

Considering the purpose of the research, it was important to evaluate the quality of the obtained granulate. The size of the granules created in the granulation process is an important quality feature. Noticeably, in all the tested combinations, granules of more than 1.0 mm in diameter were obtained and they were always bigger than the test combinations (0.81 mm) (Figure 4).

While evaluating the distribution of the obtained material on the sieves, the influence of all the tested elements can be noticed in comparison with the control combination. In view of the mechanical features, the most valuable granules were mushroom granules obtained from the test combination containing 10% starch solution, which creates granules of above 1.0-2.0 mm in diameter – most appropriate from the practical point of view (Figure 5).

Water contained in granules is very important because of the possibility of microbiologic infection and due to the preservation of the features of biologically active substances that are present in mushroom granules. The high content of water in the control combination is understandable. The content of water in granules created with starch of 5.0 and 10.0% concentration, and with starch syrup with 40% concentration is similar. Higher water content was observed in the test combinations with 60% starch (Figure 6).

The content of water in mushroom granules should be subject of further research. The water content is important, alongside with the other features influencing the quality of granulate, for the preservation of the smell substances which are essential for mushroom powders.

Granules of the biggest size were created in test combination where the binding substance was 10% starch solu-

TABLE 1. List of average values of physical properties of mushroom powder.

Moisture content	Chute angle	Angle of repose	Bulk density	Shaken density	Average measurement of a particle
13.4%	40°	33.42°	463.12 kg/m^3	683.93 kg/m^3	0.22 mm

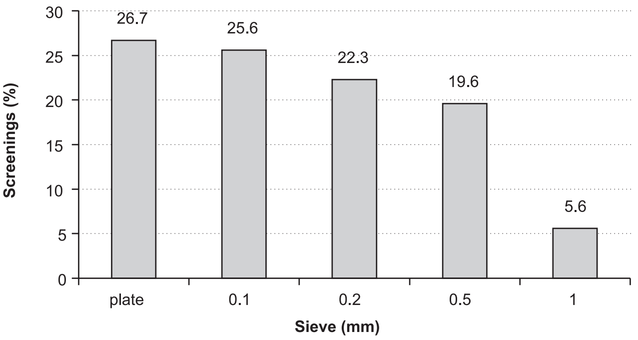

FIGURE 3. Granulometric distribution of mushroom powder on each sieve.

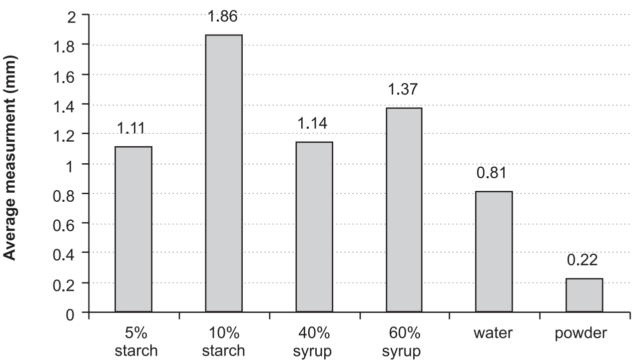

FIGURE 4. Average measurement of granulate.

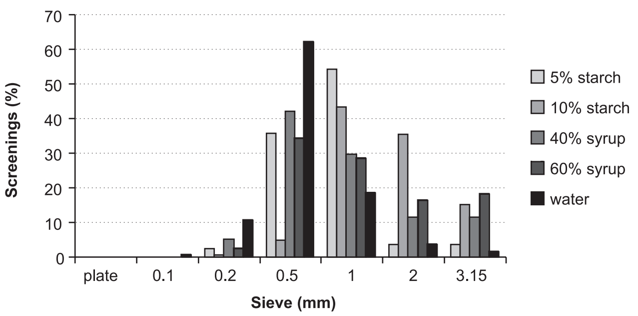

FIGURE 5. Distribution of granulate on sieves.

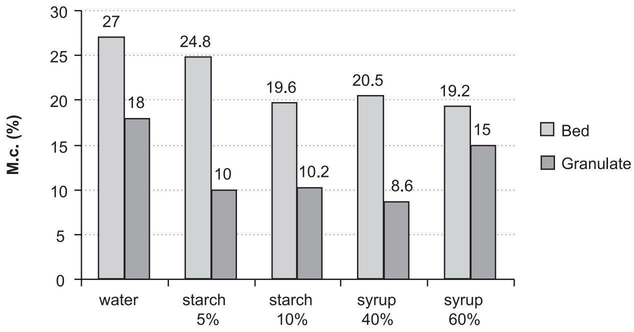

FIGURE 6. Moisture content of granulate.

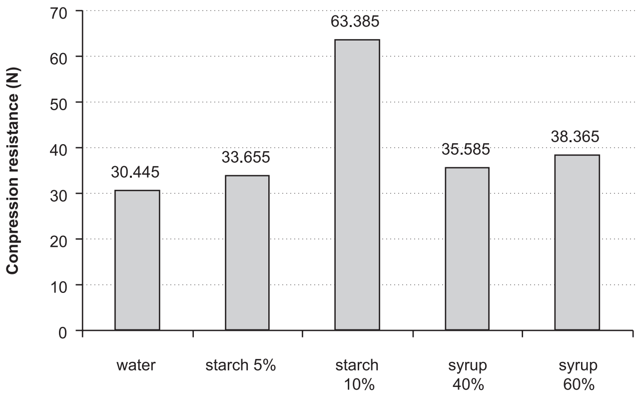

FIGURE 7. Resistance to compression of the granulate.

tion. Their resistance to compression is the most important stability feature in view of their utility. Such granules were also obtained when 10% starch solution 64.4N was applied. The value was almost twice as high as the values for the remaining combinations in the research. The value for 5% starch combination was 33.6N, while for 40% syrup – it was 35.6N (Figure 7).

There were statistically significant differences of the compression resistance between the granulate that was obtained using 10% potato starch solution – and the other granulates.

CONCLUSIONS

1. The biggest granules were obtained with 10% potato starch solution (1.8 mm). Diminishing the share of starch two times (5%) led to a decrease of the granule size of about 40%. The smallest granulates were created when distilled water was added (0.81 mm).

2. The granules obtained with 10% potato starch solution were characterized by the highest compression resistance (twice as high as that of the other granules).

3. It is possible to produce mushroom granulate for further storage or as a new technological product.

REFERENCES

1. Hogekamp S., Schubert H.S., Wolf S., Steam jet agglomeration of water soluble material. Powder Technol., 1996, 86, 49-57.
2. Iveson S.M., Litster J.D., Hapgood K., Ennis B.J., Nucleation, growth and breakage in agitated wet agglomeration processes. Powder Technol., 2001, 117, 3-39.
3. Jetzer W., Leuenberger H., Sucker H., The compressibility and compatibility of pharmaceutical powders. Pharm. Technol. 1983, 11, 33-48.
4. Kawala Z., Kapłon J, Krakowski R. Validity aspects of sublimation drying. Food Industry, 1993, 3, 64-76.
5. Korpal W., Weiner W., Application of non-pressure granulation in utilisation of dust refuse. Ecol. Technol., 1998, 6, 44-49.
6. Łobaszewski E., Paczyńska B., Zalewski S., Characteristics of smell and taste agents of mushrooms. Food Industry, 1990, 10, 244-245.
7. Macura R., Application of sublimation process to production of spice-vitamin in tomato. Scientific Books of University in Krakow, 1994, 6, 175-182.
8. Rooij de J.F.M., Biosciences and separation technologies. Creating '3 rd generation of food. Food Engin., 1990, 9, 30-31.

GRANULACJA BEZCIŚNIENIOWA PROSZKU GRZYBOWEGO

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Produkty spożywcze o znacznym rozdrobnieniu są bardzo niewygodne do stosowania w warunkach domowych, jak i w procesie technologicznym. Największymi wadami takich produktów jest ich pylistość oraz problemy w przechowywaniu ze względu na dużą higroskopijność i tendencję do zbrylania się. Celem pracy było zbadanie wykorzystania granulacji bezciśnieniowej do produkcji aglomeratu z suszonych, sproszkowanych grzybów z różnymi dodatkami wiążącymi tj. skrobia, syrop ziemniaczany, woda – jako próbka kontrolna oraz pomiar podstawowych właściwości fizycznych i wytrzymałościowych. Wyniki pomiarów poddano obróbce statystycznej. Przeprowadzono podstawowe obliczenia tj.: średnią, odchylenie standardowe, wariancję, błąd standardowy. Następnie przeprowadzono analizę wariancji na poziomie istotności $\alpha=0,05$. Różnice istotne statystycznie wystąpiły dla odporności na ściskanie pomiędzy granulatem uzyskanym z roztworem 10% skrobi ziemniaczanej a pozostałymi. Największe wymiarowo uzyskano granulki z roztworem 10% skrobi ziemniaczanej (1,8 mm). Dwukrotne zmniejszenie udziału skrobi (5%) spowodowało zmniejszenie wielkości granulek o ok. 40%. Najmniejsze granulaty powstały z dodatkiem wody destylowanej (0,81 mm).