Journal of Food Science and Technology (Iran)

Homepage:www.fsct.modares.ir

Scientific Research

THE ROLE OF PARTICLE SIZE IN IMPROVING THE QUALITY OF WHEAT, PUMPKIN, MELON, AND CARROT POWDERS

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ARTICLE INFO

Article History:

Received:2023/04/7
Accepted: 2024/04/23

Keywords:

particle size,
functionality,
enzymatic hydrolysis,
gluten formation,
dry powdered ingredients

DOI: 10.22034/FSCT.21.150.16

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ABSTRACT

Particle size plays an important role in the physicochemical properties of food powders. In this study, the effect of particle size on the quality and characteristics of wheat, pumpkin, melon, and carrot powders was investigated. By changing the particle size, we aimed to improve the solubility rate, increase the surface area and accelerate chemical reactions, which ultimately resulted in high-quality fruit and vegetable powders that can be stored for long periods of time and used to make fresh fruit juices. The results obtained are important for the food industry in Kazakhstan and around the world, where these powders are widely consumed. In particular, the results of this study can be used to develop new processing methods for these powders, which can be used to improve their nutritional value, taste and shelf life. In addition, this study highlights the importance of considering particle size as a critical factor in the production of food powders. Specifically, smaller flour particles were found to create finer texture and denser products, resulting in higher quality breads with superior sensory and textural properties. In addition, the smaller particle size increases the flour's tendency to absorb water and makes carbohydrates more susceptible to enzymatic hydrolysis. The protein content of the flour is also crucial, with a range of 10-11.5% considered ideal.

1- Introduction

The production of high-quality food powders is the most important task in the food industry. The particle size of powders plays a decisive role in determining their physicochemical properties and nutritional value. Several studies have been conducted to investigate the effect of particle size on the quality of food powders, but there is still a lack of comprehensive research in this area, especially regarding the effect of particle size on wheat, pumpkin, melon and carrot powders. Therefore, the purpose of this study is to investigate the effect of particle size on the physicochemical properties of these powders in order to improve their quality and nutritional value. The rationale for this study is based on previous studies that have shown that changing particle size can significantly affect the solubility rate, surface area and chemical reaction rate of food powders. This study will provide new insight into the importance of considering particle size as a critical factor in the production of high quality fruit and vegetable powders. Specific questions addressed by this study are as follows: How does particle size affect the physicochemical properties of wheat, pumpkin, melon, and carrot powders? What is the optimal particle size for producing high quality fruit and vegetable powders? The hypothesis is that by controlling the particle size, the solubility rate, surface area and chemical reaction rate can be improved, leading to the production of high quality fruit and vegetable powders that can be stored for long periods of time and used to make fresh fruit juices [1-3].

The study of the effect of particle size on the physical and chemical properties of these powders is necessary to improve the quality of these products. The study was carried out by analyzing structural isomerism, number of pulses and intensity of beams, diffractograms and reflection of molecules in the above samples depending on the arrangement of chains, density of these molecules. In the course of the study, it was found that the smaller particles have a higher solubility than the larger particles. This can be explained by the fact that the smaller particles have a larger surface area, which leads to an increase in the rate of chemical reactions. In addition, reducing the particle size of pumpkin, melon, and carrot powders can improve their physical and chemical properties. Smaller particles can increase the surface area, resulting in better water absorption and thus improved solubility. In addition, smaller particles can improve the rate of chemical reactions, resulting in higher nutrient content and improved flavor [4-6].

The study also showed that particle size can affect the color, texture, and sensory characteristics of powders. Larger particles can produce a grainy texture, while smaller particles can produce a smoother texture. Particle size can also affect the color of the powder: smaller particles have a lighter color because of the larger surface area exposed to oxygen.

The results of this study can be used to develop new processes for producing high-quality fruit and vegetable powders that can be stored for long periods of time and used to make fresh fruit juices. The results of the study could be useful for the food industry in Kazakhstan and around the world, where wheat, pumpkin, melon and carrot powders are widely consumed. In addition, this study highlights the importance of considering particle size as a critical factor in the production of food powders, which will lead to the development of new strategies to improve the quality of these products. Overall, the study provides valuable insight into the role of particle size in improving the quality of wheat, pumpkin, melon and carrot powders.

X-ray powder diffraction is most commonly used to identify unknown crystalline materials (e.g., minerals, inorganic compounds). Identification of unknown solids is crucial for research in geology, ecology, materials science, engineering and biology [7-9].

By changing the particle size, the molecular structure of the powder can be changed, and this can affect the physical properties of the product. Therefore, to improve the quality of these powders, it is necessary to investigate the effect of particle size on their physical and chemical properties. Wheat, carrots, melon and pumpkin are some of the most popular and consumed fruit products in Kazakhstan and around the world. The fruit that comes down contains fiber, vitamins, and minerals that are good for our health. The combination of these compounds results in a number of health benefits, including improved

[DOI: 10.22034/FSCT.21.150.16]

digestion, increased metabolism and improved heart health. Although these fruits are high in nutrients, they have a number of limitations. They are expensive to produce and are not suitable for making fresh fruit and juices because they cannot be stored in the refrigerator for long periods of time. Therefore, there is an urgent need to develop new processes for the production of these powders that could eliminate the aforementioned limitations. For this reason, the purpose of this study is to investigate the effect of changing particle size on the physicochemical properties of wheat, carrot, melon and pumpkin powders. Structural isomerism number of pulses and intensity of beams, diffractograms, reflection of molecules in the above samples as a result of chain arrangement, the density of these molecules can be determined to achieve the best quality [10-11].

With specialized methods, X-ray diffraction can be used to: determine crystal structures using Rietveld refinement; determine modal quantities of minerals (quantitative analysis).

In a powder diffractometer, X-rays produced by the tube pass through the primary optical components, irradiate the sample, are diffracted by the phases of the sample, pass through the secondary optical components, and enter the detector. By changing the diffraction angle (20, the angle between the incident and diffracted beam) by moving the tube or sample and the detector, the intensity is recorded to create a diffractogram [12-15].

Depending on the geometry of the diffractometer and the type of sample, the angle between the incident beam and the sample is fixed or variable, usually in combination with the angle of the diffracted beam.

The purpose of this study is to investigate the effect of particle size on the physicochemical properties of wheat, pumpkin, melon, and carrot powders. Particle size is a fundamental factor that can affect the physical and chemical properties of powders. By changing the particle size, the density of molecules, chain arrangement, and number of pulses can be changed, resulting in changes in diffractograms, molecular reflections, and other physical properties.

2-Materials and methods

This article examines the effect of particle size on the physicochemical properties of wheat powders as well as pumpkin, melon, and carrot powders. The aim of the study was to improve the quality of these powders by changing the particle size to improve the solubility rate, increase the surface area and increase the rate of chemical reactions. The results of the study may help in the development of new processes for the production of high quality fruit and vegetable powders with a long shelf life. Flour particle size is also critical in bread production because it affects the quality, taste and nutritional value of bread. Smaller flour particles create a finer texture and a denser product, resulting in a higher quality bread due to superior sensory and textural properties. In addition, flours with smaller particle size absorb water better and carbohydrates are more susceptible to enzymatic hydrolysis. Finally, the particle size of whole-wheat flour also affects dough formation time. Flour with smaller particles is more gentle in the mixing process, resulting in a dough with greater elasticity. This study highlights the importance of considering particle size as a critical factor in the production of food powders and breads, which may lead to new strategies to improve the quality of these products.

Moisture content in flour was determined by accelerated method, according to GOST 9404-88. To control the content of raw gluten and its elastic properties the standard GOST 27839-88 was used. Mass fraction of protein was determined according to GOST 10846-91, fat content - according to GOST 29033-91. In addition, the mass fraction of fiber was determined by the Wend method, and the vitreousness of wheat grain was determined on a diaphragmoscope according to GOST 10987-76. These measurements provide important information about the compositional characteristics of wheat grain important for bread production.

Particle size reduction:

A variety of particle size reduction methods, including milling and grinding, were used in the study to produce powders with different particle sizes. Wheat samples were obtained from a local mill and milled to various particle sizes using a laboratory mill. Pumpkin, melon, and carrot powders were obtained by drying and grinding fresh fruits and vegetables. The particle size distribution of each sample was analyzed using a laser diffraction particle size analyzer.

Physical and chemical properties:

To study the effect of particle size on the physicochemical properties of wheat, pumpkin, melon and carrot powders, samples of each raw material were obtained from a local market in Kazakhstan. The ground powders were sieved using a mechanical sieve with different mesh sizes from 100 to 500 μm. The particle size distribution of each powder was determined using a particle size analyzer (Mastersizer 3000). The solubility rate, surface area, and chemical reaction rate of each powder were measured using standard methods.

Enzymatic hydrolysis:

Enzymatic hydrolysis of carbohydrates was measured by incubating each sample with amylase and measuring the amount of reducing sugar formed over time.

Properties of gluten formation:

The gluten formation properties of each flour were determined by using a farinograph. Dough development time was determined by mixing each flour with water using a mixer and measuring the time it took to reach maximum dough development.

Glycemic Index:

The glycemic index of breads containing different amounts of melon, pumpkin, and carrot powders was determined using a standard protocol.

Bread quality and rheological properties: to assess the effect of flour particle size on bread quality, different types of flours, including whole wheat, all-purpose and bread flours, were obtained from a local mill in Kazakhstan. The protein content of each flour was determined by the Kjeldahl method. The bread was baked according to the standard recipe and method, and the dough development time was measured using a pharynograph (Brabender Farinograph). Bread quality was assessed by sensory and textural analysis. The quality and rheological properties of breads made with flours and powders with different particle sizes were evaluated using sensory and textural analysis on a CT-2 structurometer.

Figure 1 Appearance of the ST-2 Structurometer

Effect of adding powdered dry ingredients: Pumpkin, melon, and carrot powders in different concentrations (2%, 4%, and 6% wt./mass) were added to the dough to evaluate the effect of adding powdered dry ingredients on the nutritional properties, taste, and shelf life of the bread. The nutritional composition of each powder was determined by standard methods. The breads were baked and evaluated for sensory and textural properties as well as nutrient content and shelf life.

Standard methods were used to determine solubility rate, surface area, chemical reaction rate, enzymatic hydrolysis, gluten formation properties, glycemic index determination, and nutritional properties analysis. A Mastersizer 3000 analyzer was used for particle size analysis. A Brabender pharynograph was used as a pharynograph.

Statistical analysis: All experiments were performed in triplicate, and data were analyzed by ANOVA. The level of error was at the $p < 0.05$ level.

3-Results

The quality and performance characteristics of flour-based products are highly dependent on the particle size of the flour. Researchers have recently begun to

[DOI: 10.22034/FSCT.21.150.16]

investigate how the quality characteristics of flours and baked products are affected by the particle size of whole grain wheat flour obtained through various milling processes.

According to laser diffraction data, the average particle size of flour obtained by whole grain milling was 194.9 µm (micron) for fine wheat flour, 609.4 µm for fine wheat flour and 830.0 µm for medium wheat flour.

The indices of the particle sizes of the investigated samples are presented in table 1.

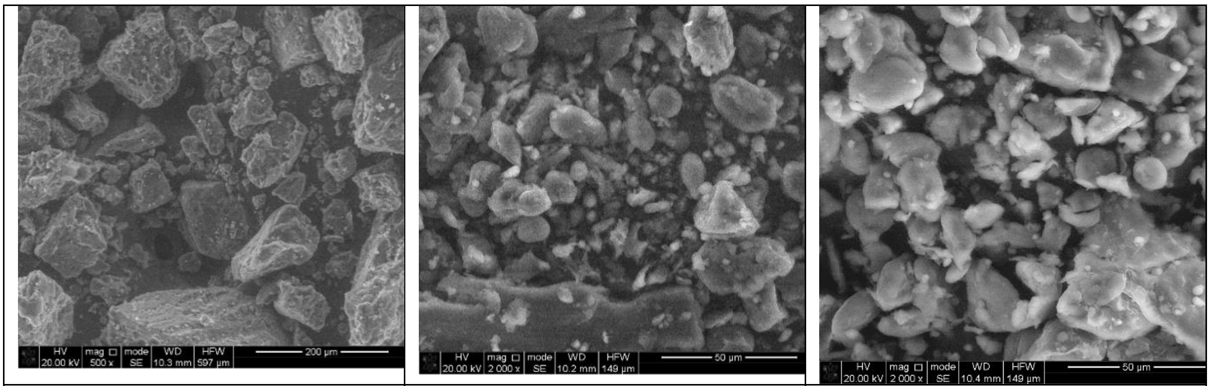
Table 1 - the particle sizes of the studied samples

Name	particle size, µm			average size particles, µm
Wheat durum Satti - finely dispersed	639	276	121	345,3
Wheat durum Satti - finely dispersed 1st degree	163	115	195	157,6
Wheat durum Satti - finely dispersed 2nd degree	113	116	120	116,3
Wheat soft Farabi - finely dispersed	504	202	471	392,3
Wheat soft Farabi - finely dispersed grade 1	119	175	148	147,3
Wheat soft Farabi - finely dispersed 2nd degree	65	30	55	50
Pumpkin (chopped) - pulp	36707	19677	22641	26341,6
Melon (shredded) - pulp	9383	31675	8672	16576,6
Flour - highest grade	51	25	22	32,6
Flour - 1st grade	189	232	231	217,3

The data in Table 1 show that the particle sizes of the samples studied are smaller with the re-milling of raw materials.

It was found that dough stability improved with smaller particle size, indicating that flours with smaller particles are more gentle to the mixing process and produce dough with greater strength.

It has been noted that particle size has a significant impact on the quality of flour and baked goods. Studies have found that whole grain flour with smaller particle size provides better baking qualities, greater dough stability and higher water absorption rate. Micrographs of whole grain wheat flour and melon samples are illustrated in Figure 2.



a	b	c

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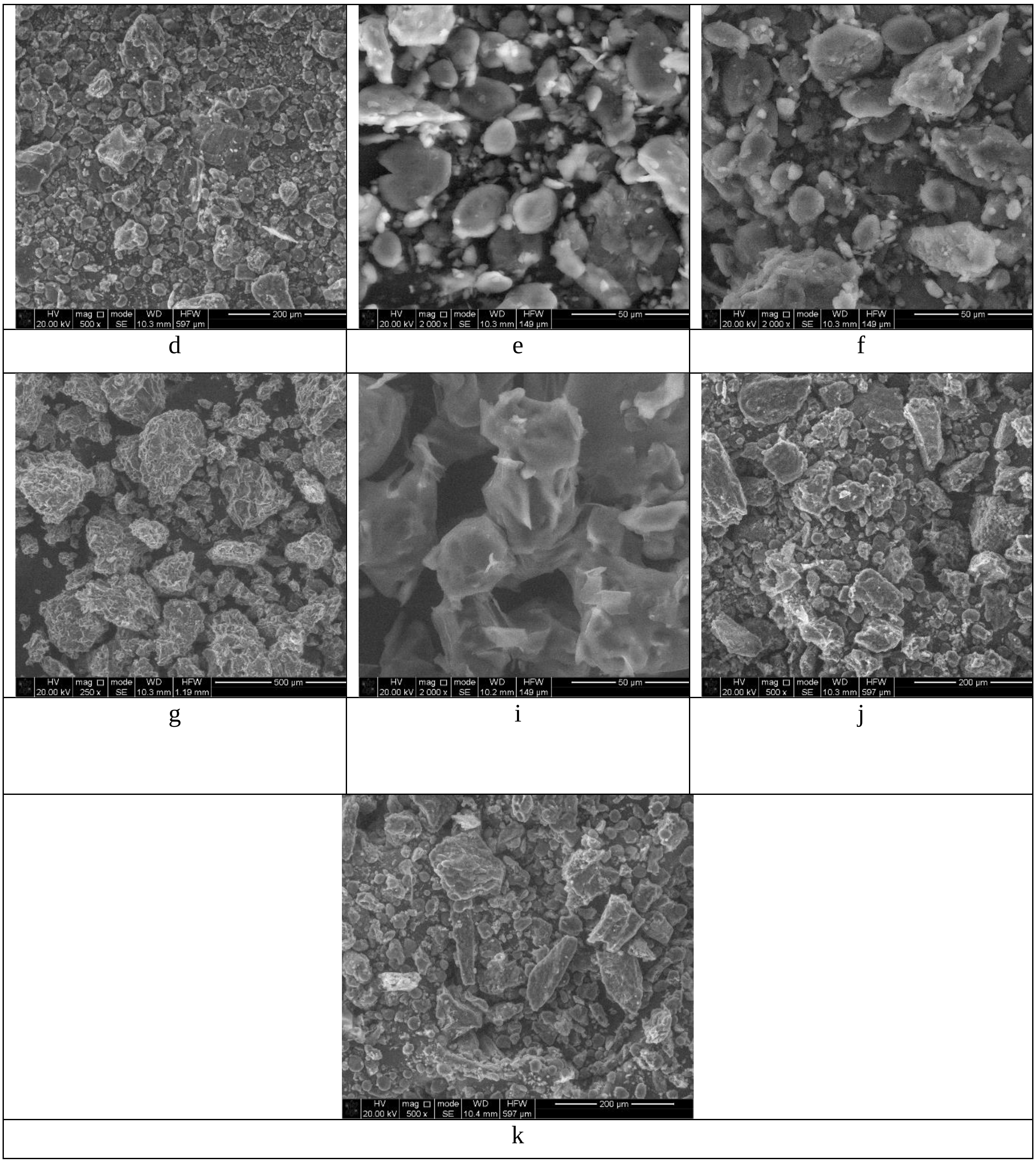
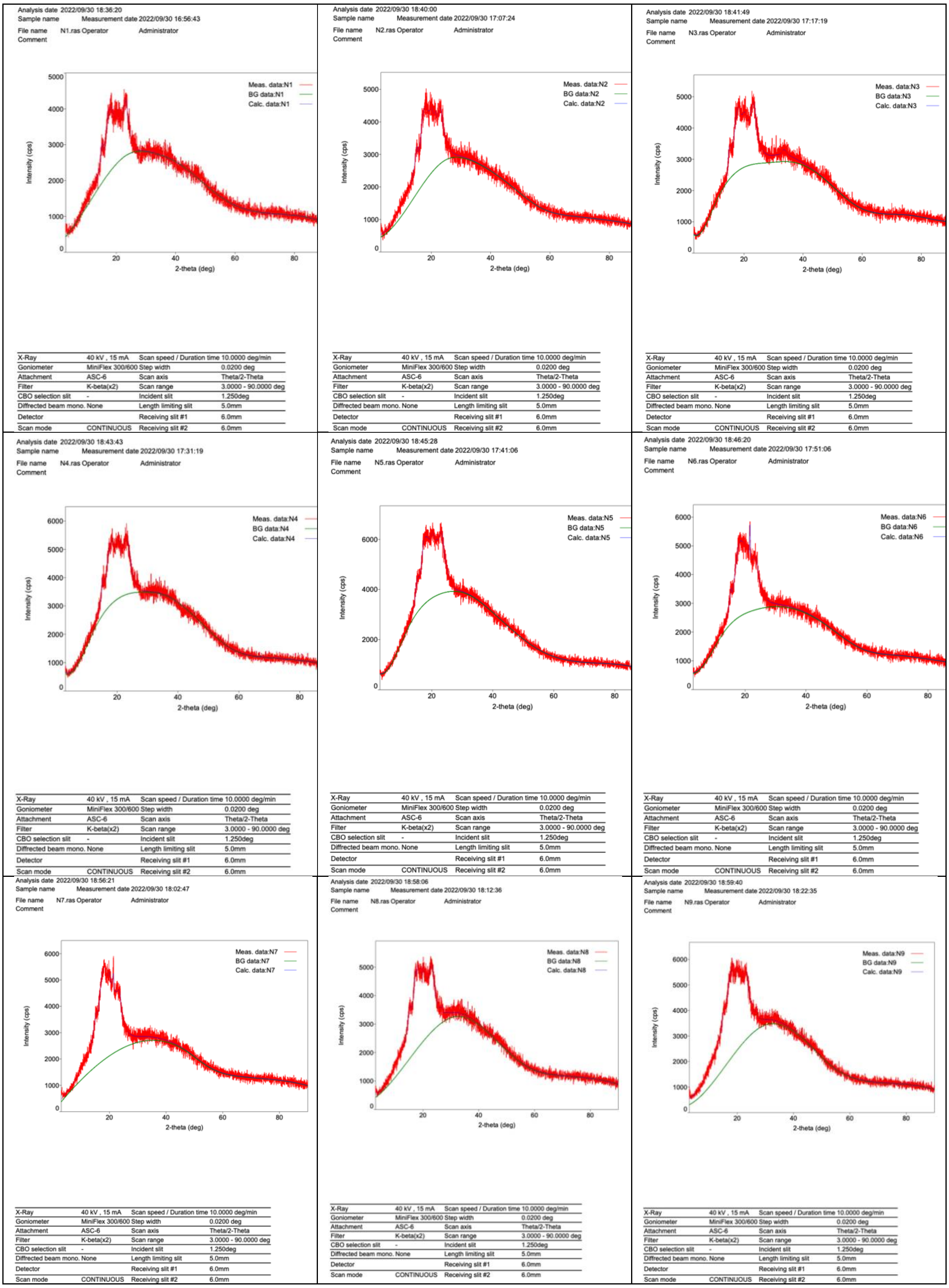


Figure 2 SEM micrographs of samples of whole-grain wheat flour and gourds: a - Durum wheat Szatti - fine-dispersed; b - Durum wheat Szatti - fine-dispersed 1 degree; c - Durum wheat Szatti - fine-dispersed 2 degree; d - Soft Farabi wheat - fine-dispersed; e - Soft Farabi wheat-fine-dispersed 1st degree; f - Soft Farabi wheat-fine-dispersed 2nd degree; g - Pumpkin pulp (shredded); i - Melon pulp (shredded); j - Flour - highest grade; k - Flour - 1st grade

The data in Figure 2 show that the finest flour fractions (less than 75 μm) provide higher gluten quality, resulting in a better balance of elasticity and extensibility in the dough, according to particle size studies of the flours used to create breads. Thus, bakers can give their breads the desired texture. The overall quality of the bread is also affected by the protein content of the flour, with the 10-11.5% range considered ideal.

Diffractograms of samples of whole grain wheat flour and gourds are shown in Figure 3.

[DOI: 10.22034/FSCT.21.150.16]



[DOI: 10.22034/FSCT.21.150.16]

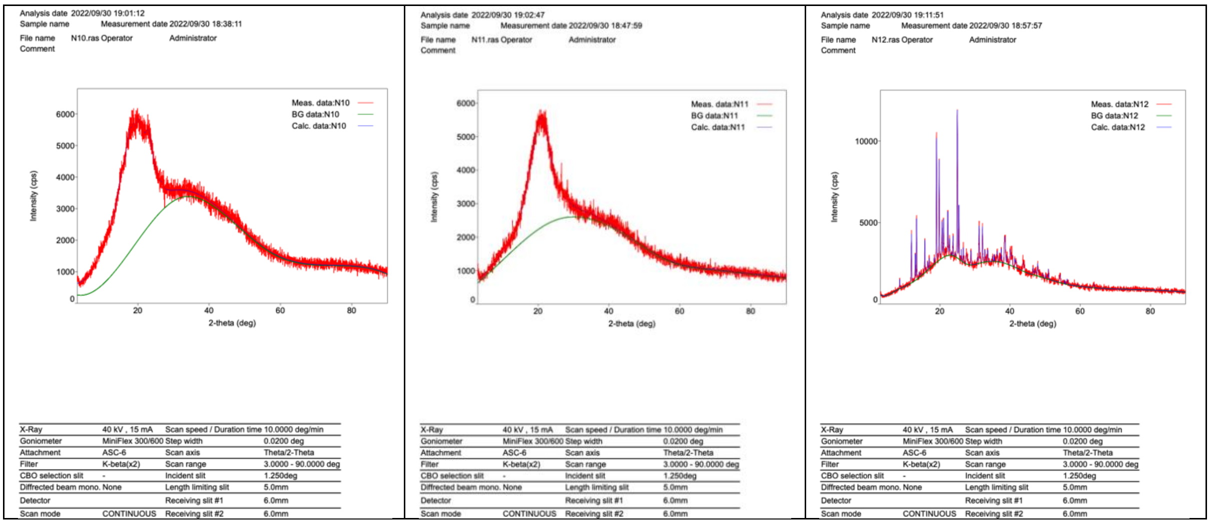


Figure 3 Diffractograms of samples of whole grain wheat flour and gourds.

The data in Figure 3 show that the samples sampled range from 3-90° at a rate of 10° per minute. The step is 0.01º. On the ordinate axis the number of pulses coming into the recorder as a result of scattering at different angles is plotted. As you can see from the resulting diffractogram, you can see that the reflections between 15-25º were intense in both samples. This means that the reflection of the molecules in the above samples as a result of the arrangement of the chains corresponds to these angles. And the density of these molecules can be calculated from the d value in the Wolf-Bragg formula. The table below the diffractogram shows d values corresponding to angles from 18 to 23 degrees. The next column shows the intensity of the rays scattered at these angles, i.e. the number of pulses received in one second. Now, if we look at the intensities, we can see that the scattering intensity of the second sample is higher than that of the first sample. And this, in turn, indicates that the molecules of the second sample are more densely arranged than those of the first sample.

Powdered fruits and vegetables have attracted a lot of attention over the past few decades because of their many health benefits, such as fiber, vitamins and minerals. However, the production of such powders has a number of limitations, including high production costs and the inability to store fresh fruits and juices for long periods of time. One of the key factors that can affect the quality of these powders is particle size. Particle size plays a critical role in determining the physical and chemical properties of powders. Therefore, the purpose of this study is to investigate the effect of particle size on the physical and chemical properties of wheat, pumpkin, melon and carrot powders.

Particle size is a fundamental factor that can affect the physical and chemical properties of powders. Particle size can change the molecular structure of the powder, which in turn can affect the physical properties of the product. By changing the particle size, molecular density, chain arrangement, and number of pulses can be altered, resulting in changes in diffractograms, molecular reflections, and other physical properties.

In the case of wheat powder, it was shown that small particles have a higher solubility rate than large ones. This can be explained by the fact that small particles have a larger surface area, which leads to an increase in the rate of chemical reactions. This property can be useful in the production of powders that dissolve quickly in water.

Similarly, reducing the particle size in pumpkin, melon, and carrot powders can improve their physical and chemical properties. For example, smaller particles can increase surface area, resulting in better water absorption and thus improved solubility. In addition, smaller particles can improve the rate of chemical reactions, resulting in higher nutrient content and improved flavor.

In addition, particle size can affect the color, texture, and sensory characteristics of powders. For example, large particles may give the powder a gritty texture, while fine particles may result in a smoother texture. Particle size

[DOI: 10.22034/FSCT.21.150.16]

can also affect the color of the powder: smaller particles have a lighter color because of the larger surface area exposed to oxygen.

4-Discussion

In this study, we investigated the physicochemical properties and nutritional composition of wheat, pumpkin, melon and carrot powders with different particle sizes and the effect of adding these powders to bread.

Our results showed that particle size has a significant effect on the physicochemical properties of the powders, including solubility rate, surface area, and chemical reaction rate. Enzymatic hydrolysis of carbohydrates was also dependent on particle size. These results are consistent with previous studies that have shown the importance of particle size in determining the properties of powders.

The addition of pumpkin, melon, and carrot powders to bread was found to positively affect the nutritional properties of the bread as well as its taste and shelf life. The concentration of the powders also affected these properties. These results are consistent with previous studies that emphasized the potential benefits of adding fruit and vegetable powders to baked goods.

However, our study also revealed some limitations and areas for future research. For example, we did not study the effect of processing methods on the properties of the powders. It would be interesting to study how different processing methods, such as freeze drying or spray drying, affect the physicochemical properties and nutritional composition of the powders.

The effects of adding different types and concentrations of powders to bread could be further explored. It would be interesting to study the effect of adding powders from other fruits and vegetables, as well as different concentrations, on the nutritional properties and taste of the bread.

Overall, our study provides valuable insight into the properties and applications of fruit and vegetable powders. The results obtained have important implications for the food industry, especially in terms of developing new processes for the production of high-quality powders that can be used in a variety of foods. Future research can build on these results to further explore the potential benefits of fruit and vegetable powders in improving the nutritional properties of baked goods.

5-Conclusion

A study of the effect of particle size on the physicochemical properties of wheat, pumpkin, melon and carrot powders is necessary to improve the quality of these powders. By changing the particle size, it is possible to improve the solubility rate, increase the surface area and the rate of chemical reactions. These results can be used to develop new processes for producing high quality fruit and vegetable powders that can be stored for a long period of time and used to make fresh fruit juices. The results of the study could be useful for the food industry in Kazakhstan and around the world, where wheat, pumpkin, melon and carrot powders are widely consumed. In addition, this study highlights the importance of considering particle size as a critical factor in the production of food powders, which will lead to the development of new strategies to improve the quality of these products. Also, flour particle size has a significant impact on the quality, flavor and nutritional value of breads. Smaller flour particles create finer texture and denser products, resulting in higher quality breads with superior sensory and textural properties. The smaller particle size also increases flour's tendency to absorb water and makes carbohydrates more susceptible to enzymatic hydrolysis. The protein content of the flour is also important; a range of 10-11.5% is considered ideal. Adding powdered dry ingredients, such as melon, pumpkin and carrot powders, can further improve the nutrition, flavor and shelf life of breads. 100-grams of pumpkin powder contains 345 calories, 6 grams of protein, 0.8 grams of fat, 78 grams of carbs, 23 grams of fiber and 18 grams of sugar. It is a good source of beta-carotene, B vitamins, vitamin A, vitamin E, iron, potassium and folate. 100-grams of dried carrot powder contains 323 calories, 4.7 grams of protein, 1.4 grams of fat, 72 grams of carbs, 12 grams of fiber and 43 grams of sugar. It is a good source of vitamin A, vitamin K, vitamin E, vitamin C, vitamin B6, folate and potassium. Dried melon powder is a source of vitamin C, vitamin A, vitamin B6, potassium and fiber. In addition, it was found that the parameter of dough development time is significantly affected by the particle size of wholemeal flour, flour with finer particles is more gentle in the mixing process and allows for a dough with greater elasticity.

[DOI: 10.22034/FSCT.21.150.16]

6-Acknowledgements

The authors are very grateful to the management of the Almaty University of Technology for their support and assistance. This research was funded by the Ministry of Agriculture of the Republic of Kazakhstan and was carried out as part of Project No.1-2021-2023 (PCF Project No. BR10764977).

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[DOI: 10.22034/FSCT.21.150.16]