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Analysis of changes in bread during frozen storage with pre-cooking and steaming

Siti Nur Azizah[*], Wisnu Adi Yulianto, Ch. Lilis Suryani

[*] Department of Agricultural Product Technology, Faculty of Agro-industry, University of Mercu Buana Yogyakarta, Indonesia, Jl. Wates Km 10, Argomulyo, Bantul, Yogyakarta, Indonesia 55753

*✉ inungstemba@gmail.com

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ABSTRACT

Frozen storage methods in bakery products have been widely applied to maintain quality and extend shelf life. Early cooking by steaming followed by frozen storage on bread is an effective way to slow down the spoilage process. The length of time frozen storage affects the physical, chemical, microstructure, thermal, and sensory reception properties. The purpose of this study is to evaluate the quality of bread by pre-cooking steaming during frozen storage and after re-cooking. The research was carried out with the storage time treatment factors, time of 0, 14, 28, 42, 56 and 70. Parameters analyzed in frozen bread include texture testing, volume expansion rate, moisture content, dissolved protein content and crumbs (SEM), thermal properties with Differential Scanning Calorimatry, as well as the level of preference. The result showed that the longer the frozen storage, the harder the texture, the level of volume development, the lower the water and dissolved protein content and the smaller the pores of the bread. Bread texture increased in hardness along with the lenght of frozen storage, namely 8.70 N increased to 17.44 N, while the water content decreased from 30.02% (w/w) to 26.70% (w/w). the highest soluble protein content was obtained on the 14th day which was 1.53% and the lowest was on the 70th day, which was 1.31%. The result of the SEM test showed that there was a reduction in the pore size of bread compared to on day 0. The results of DSC thermogram showed that the longer the frozen storage of bread with the initial cooking of steaming, the lower the gelatinization and enthalpy temperatures, and the smaller the pore size is small. Storage of frozen bread until day 56 resulted in bread quality that has nor changed and is still accepted by the panelists.

Keywords: Bread change; frozen storage; and pre cooking steaming.

1. INTRODUCTION

Increasing the welfare of the population resulted in lifestyle changes including food consumption patterns [1]. This change has prompted food supplies at the household level to also begin to shift from originally using fresh food to partially switching to frozen food products. Food freezing technology can be a solution in extending the shelf life and durability of a product [2]. Frozen Food Technology is a technology for preserving food by lowering its temperature below the freezing point of free water [3]. Decreasing the storage temperature will inhibit the growth of microorganisms and the activity of enzymes in food products, so that food becomes more durable and does not spoil easily. The advantage of the food freezing technique is that the quality of the food such as nutritional value, level of freshness and organoleptic properties is maintained [4].

One product that is widely consumed is bread. Bread is consumed all over the world because it can be used as a source of energy by serving quickly and at a low price. Bread is produced through a process of fermentation and roasting so that the distinctive characteristics of the aroma, taste and texture of the bread are obtained [5]. The main quality parameter of bread is freshness, which is the condition of aroma, taste and texture which is the best and can be accepted by consumers [6]. However, bread is a shortlived product because its freshness quickly decreases due to physicochemical changes such as a decrease in water content which causes hardness of the bread, and the aroma evaporates as well as microbiological changes (growth of mold) on the bread [7]. The decline in the quality of bread causes bread to be unfit for consumption so that a large amount of bread will be thrown away or diverted as animal feed and results in economic losses for bread producers.

Parboiling of bread and further storage at freezing temperatures is an effective way to slow down the spoilage of baked goods. Freezing turns the water present in food into inactive compounds and low temperatures will inhibit the growth of microorganisms and the activity of enzymes that trigger food spoilage. The volume expansion of bread baked the second time after it has been partially baked and then frozen is better than that of bread baked from frozen dough [8]. Pre-baking followed by frozen storage can extend the shelf life of bread, but frozen storage time, partial baking time and freezing speed significantly affect the specific volume and toughness of par-baked bread. Long frozen storage time on pre-baked bread causes a decrease in bread quality due to loss of water content and hardening of the bread. Microstructural test results on frozen pre-baked bread showed that the longer the frozen storage, the formation of ice crystals would cause physical damage to the bread [9].

In addition, the freezing process will also cause retrogradation of amylose within a few hours and after a few days following the retrogradation of some amylopectin. Retrogradation is the change from amorphous gel to crystalline that occurs in gelatinized starch during storage. Early development of crystallinity occurs in the amylose fraction and long-term changes are characterized by crystallinity in the amylopectin fraction. Currently, many studies have been carried out on frozen storage methods for both bread dough and parboiled bread. Frozen storage and temperature fluctuations during storage cause loss of dough and bread quality due to lower gas production, longer water mobility, and more uneven distribution of breadcrumb structure [10]. The longer storage at freezing temperatures of half-baked bread also causes a decrease in the quality of bread due to loss of water content and bread hardness [11], but until now there has been no research on the effect of frozen storage on bread with pre-cooking by steaming. Therefore, it is necessary to study the effect of the process of freezing bread with initial steaming on quality after it is steamed/fried again before serving. It is necessary to study the effect of frozen storage time and cooking method on the physicochemical, thermal and microstructural characteristics of frozen bread with initial steaming.

2. METHOD

The research was conducted at the Laboratory of the Faculty of Food Technology and Agricultural Products, Gadjah Mada University, Jln. Flora 1 Bulaksumur Yogyakarta for water content test, texture test and cultured protein test. The DSC (Differential Scanning Calorimetry) thermogram test was carried out at LPPT Gadjah Mada University, Jalan Kaliurang Km. 4 Sekip Utara, Sendowo, Sinduadi, Depok District, Sleman Regency, Yogyakarta. The microstructure test of bread using the SEM (Scanning Electron Microscopy) method was carried out at the Integrated Laboratory of the Islamic University of Indonesia, Jalan Kaliurang Km.14.5 Yogyakarta. The sample making process was carried out at AnnaBil Cake n Bakery, Nguwet Kranggan Temanggung. The volume development test was carried out in the Laboratory of Basic Processing Process of Agricultural Products at SMKN 1 Temanggung, Jalan Content Box Post 104 Sidorejo Temanggung. The time of the research was carried out in July 2021 - March 2022.

The equipment needed in this study consisted of the main equipment for making frozen bread including digital scales (camry), spiral mixer SMX-HS30B, dividers, rollers, plastic basins, baking sheets, steamers (placards), impofers, spatulas, scrubbers, plastic trays and sealers. While the equipment used in the test included a freezer, moisture tester (44-15A), texturometer (TA-XT21), moving electron microscope (Cyro-SEM), DSC-60 Plus (C30935200137SA), beaker glass, volume glass and digital scales.

The analysis carried out in this study consisted of physical testing including texture hardness testing (texturometer), bread volume development level testing and bread crumbness testing (SEM), chemical testing including water content testing and dissolved protein testing, thermal properties testing using the DCS test (differential scanning calorimetric), bread crumb microstructure testing using the SEM (scanning electron microscopy) test, and organoleptic testing using the panelist's preference level test.

The research design used a completely randomized design with the studied variable being frozen storage time (-18 °C) on days 0, 14, 28, 42, 5 and 70 days with 2 repetitions. The analysis includes testing for water content, texture testing, dissolved protein testing, starch gelatinization testing (DSC), bread swelling level testing, bread microstructure testing (SEM) and liking testing.

Furthermore, a factorial study was carried out on bread volume expansion rate tests with three re-cooking methods namely steaming, steaming followed by frying and frying with a variation of 3X6 repetitions [12].

Statistical analysis was carried out with a significant 95% analysis of variance (ANNOVA). Duncan's test was used to find significant differences between samples [13]. Statistical analysis was performed using IBM SPSS Statistics Version 26 software.

3. RESULTS AND DISCUSSION

3.1 Moisture content of bread during frozen storage

The results of testing the water content of frozen bread are presented in **Table 1**. Based on the data in **Table 1**, it can be seen that there was a decrease in the water content of the bread during frozen storage (temperature -18°C) from day 0 to day 70. The water content of frozen bread during storage was significantly different, except on the 42nd and 56th day it was not significantly different. This is due to the formation of ice crystals during the freezing process which causes protein denaturation so that the ability to bind water decreases. Protein denaturation is a process where there is a change or modification of the protein structure. Gluten protein denaturation due to hydrogen bonding in the polypeptide structure of the gluten protein is damaged which causes a decrease in water holding capacity [14].

Table 1. Moisture content of bread during frozen storage at -18 °C (% wb)

No	Storage Time (days)	Test result
1	0	$30{,}02 \pm 0{,}21^{a}$
2	14	$29{,}44 \pm 0{,}21^{b}$
3	28	$28{,}95 \pm 0{,}64^{c}$
4	42	$28{,}03 \pm 0{,}58^{d}$
5	56	$27{,}66 \pm 0{,}82^{d}$
6	70	$26{,}70 \pm 1{,}08^{e}$

Note: the results followed by different letters in one line show a significant difference at the 95% level of confidence.

The data in **Table 1**. shows that there is a continuous decrease in water content the longer the frozen storage time. Storage on day 0 to day 28 experienced a significant decrease in water content, namely at a moisture content of 30.02% to 29.44% and 20.95%. The decrease in water content on day 42 and day 56 was not significantly different from 28.03% to 27.66%. On the 70th day of storage the moisture content continued to decrease to 26.70%. This is because during frozen storage, bread that has gone through a process of fermentation, cooking by steaming, and then being stored frozen causes the ability to retain water in the bread to decrease [15]. Dough water retention capacity decreases with frozen storage time, characterized by ice recrystallization on the gluten network. In addition, the amount of water that can be frozen, i.e. the fraction of free water that is not bound to gluten during dough formation, increases with the time of frozen storage because of the damage produced to the gluten network by freezing and frozen storage [16].

Storage and freezing of bread dough cause an increase in the number of free water molecules, so that ice crystallization from water contained in gluten will occur easily [17]. This also results in the amount of free water that was originally bound to gluten will increase and cause gluten damage by the presence of the clot [18]. The longer the frozen storage, the greater the amount of free water so that more will evaporate.

3.2 Dissolved protein levels

Testing for dissolved protein on frozen bread that was carried out frozen storage is presented in **Table 2**.

Table 2. Soluble protein content of bread during frozen storage at -18 °C

No	Storage Time (days)	Test result
1	0	$1{,}44 \pm 0{,}26^{a}$
2	14	$1{,}53 \pm 0{,}04^{ab}$
3	28	$1{,}48 \pm 0{,}04^{ab}$

No	Storage Time (days)	Test result
4	42	1,41 ± 0,00^{ab}
5	56	1,38 ± 0,01^{ab}
6	70	1,31 ± 0,03^{b}

Note: the results followed by different letters in one line show a significant difference at the 95% level of confidence.

The results of statistical analysis showed that the soluble protein content of bread stored frozen until day 56 was not significantly different, while that stored frozen for 70 days had decreased significantly compared to bread on day 0. These results indicated that in the protein matrix, depolymerization occurred during storage in frozen condition. The longer the depolymerization storage increases. This fact is supported by a highly significant correlation between the ratio of glutenin subunits of high molecular mass to total protein content and storage time. This phenomenon can lead to loss of gas retention capacity during fermentation.

During the fermentation process, the active mold breaks down the complex protein compounds in the material. Mold produces protease enzymes which are capable of breaking down complex protein compounds into simpler compounds [19]. Protease enzymes will degrade proteins into dipeptides and so on until they become NH3 or NH2 compounds which will disappear through evaporation. The longer the fermentation, the lower the protein content because the protease enzyme produced by yeast can hydrolyze protein into amino acids that can be used by mold for growth and development [20].

Soluble proteins are part of the protein components which are oligopeptides. Soluble proteins are composed of chains of amino acids of less than ten kinds, and have properties that are easily absorbed by the digestive system [21]. Proteins that are soluble in water and volatile due to heating are due to the presence of water-soluble amino acids as well. These amino acids have a high polar part so as to increase their solubility in water [22].

Based on **Table 2**. above, it can be seen that the increase and decrease in dissolved protein content is affected by the length of time during the fermentation process. In addition, the decrease in dissolved protein levels is affected by the length of storage due to protein denaturation that occurs during the freezing and storage processes. Protein denaturation can occur during the freezing process as a result of increased ionic strength in the intracellular network followed by the migration of water into the extracellular network [23].

The decrease in dissolved protein content was affected by the length of time frozen storage. Gluten protein and starch granules are badly damaged by long-term frozen storage. Varriano-Martson et al, have reported that water plays a role in maintaining the structure of bread dough. The broken starch granules that have separated act like a sponge in the presence of water, and may draw water from the gluten network with more breakdown. The loss of the ability of the gluten protein to retain water results in the separation of starch granules and causes damage to the structure of the bread. From the point of view of the microstructure of bread dough, the starch granules adhere firmly to the intact gluten network, but after the gluten network is broken, the starch granules show a reticular pattern and separate from the gluten network.

3.3 Texture (hardness) and volume development degree

Bread texture profile analysis was carried out to determine the main parameters of bread quality, hardness, elasticity, and softness. However, the impact that is considered the most significant is the hardness parameter where the results of the texture (hardness) test can be seen in the Table 3.

Table 3. Texture testing results (hardness)

No	Storage Time (days)	Test Results (N)
1	0	8,70 ± 1,48^{a}
2	14	11,18 ± 0,85^{b}
3	28	12,21 ± 0,97^{b}
4	42	13,50 ± 1,74^{c}
5	56	17,06 ± 0,47^{d}
6	70	17,44 ± 0,87^{d}

Note: the results followed by different letters in one line show a significant difference at the 95% level of confidence.

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From Table 3. it can be seen that there was an increase in texture hardness of the bread that was stored frozen (temperature -18°C) from day 0 to day 70. Changes in bread texture occur due to retrogradation of starch. The process of retrogradation of starch (amylopectin) which results in increased crystallization or molecular arrangement of starch polymers (amylopectin) is the main cause of the increase in crumb hardness. In addition, the trapping of some of the water in the starch crystals during the retrogradation process causes the distribution of water in the crumb to shift from gluten to starch (amylopectin) thereby reducing the availability of water as a plasticizer in the gluten matrix. This causes the texture of the crumb to become dry and brittle [24].

The increase in hardness is evidence that during the frozen storage process, damage to bread components such as amylose recrystallization occurs which plays an important role in crumb hardness. The damage produced by the starch granules by ice recrystallization, which increases with time of frozen storage, will allow leaching of intracellular amylose, increasing the interaction between amylose and intragranules and the formation of amylose networks leading to increased hardness.

Table 4. The rate of development of bread volume in several re-cooking treatments

Storage Time (days)	Steaming (%)	Steaming-Frying (%)	Frying Pan (%)
0	$1{,}11 \pm 0{,}16^{a}$	$1{,}12 \pm 0{,}11^{c}$	$1{,}37 \pm 0{,}06^{d}$
14	$1{,}11 \pm 0{,}16^{a}$	$1{,}22 \pm 0{,}11^{c}$	$1{,}36 \pm 0{,}06^{cd}$
28	$1{,}11 \pm 0{,}16^{a}$	$1{,}21 \pm 0{,}11^{c}$	$1{,}34 \pm 0{,}17^{cd}$
42	$1{,}10 \pm 0{,}16^{a}$	$1{,}21 \pm 0{,}11^{c}$	$1{,}34 \pm 0{,}17^{c}$
56	$1{,}10 \pm 0{,}16^{a}$	$1{,}17 \pm 1{,}00^{b}$	$1{,}29 \pm 1{,}00^{b}$
70	$1{,}10 \pm 0{,}16^{a}$	$1{,}09 \pm 1{,}00^{a}$	$1{,}20 \pm 1{,}00^{a}$

Note: the results followed by different letters in one line show a significant difference at the 95% level of confidence.

Based on **Table 4** it is known that the volume of bread has increased from the initial volume. This increase in volume occurred after the bread was re-cooked by steaming and also by frying. it can be seen that the re-cooking treatment affects the level of volume expansion. The treatment of re-cooking frozen bread by steaming gave no significant difference in the level of development of frozen bread volume. The longer the storage time the volume development rate decreases. There was a significant difference in the results of the volume expansion level of frozen bread with steaming re-cooking followed by frying. The longer the storage time the volume development rate decreased, there was a significant difference in the volume development rate in the 56th and 70th day of storage.

Reheating frozen bread with a frying pan directly after frozen storage results in a decreasing volume expansion rate as well. The level of volume expansion on day 0 was 1.37 ± 0.06, while on days 14 and 28 there was a significantly different decrease. The 42nd, 56th and 70th day of storage continued to experience a decrease with a significantly different level of volume development. This is due to the frozen storage process on the bread. With increasing frozen storage time, the specific volume decreases due to the development of large crystals during thawing. This water loss is reflected as crumbs during storage. In general, the volume development rate continued to decrease, due to differences in frozen storage time. Freezing time affects the increase in melting time of ice crystals due to the larger size of the ice crystals [25]. The effect of temperature on the formation of gas in bread dough is that at low temperatures the formation of CO2 gas is inhibited, whereas at too high temperatures there is too much CO2 gas so that the volume of the dough is too large (Gozalli, 2014). This shows that the longer the freezing time, the smaller the swelling of the dough because the size of the ice crystals is getting bigger.

In addition, freezing and storing the dough at -18°C resulted in a decrease in bread quality as reflected in lower loaf volume, longer fermentation time, increased proportion of gas cells, and less elasticity of the bread dough. The level of volume expansion on day 0 was 1.37 ± 0.06, while on days 14 and 28 there was a significantly different decrease. Storage on the 42nd, 56th and 70th days continued to experience a decrease that had a significantly different level of volume development. This is due to the continuous frozen storage process. The results showed that the loss of high molecular weight glutenin in the macromolecular aggregates comprising the net working of gluten was highly dependent on -18°C storage. Gluten protein in starch granules is badly damaged by long-term frozen storage. The loss of the ability of the gluten protein to retain water results in the separation of starch granules and causes damage to the dough structure. From the microstructural point of view of bread dough, the granules adhere firmly to the intact gluten network but after the gluten network is broken the starch granules show a reticular pattern and separate from the gluten network.

3.4 DSC (Differential Scanning Calorymetry)

Tests using Differential Scanning Calorymetry aim to determine the retrogradation temperature of starch in the sample. The DCS thermogram shows that the peak of retrogradation occurs at the lowest temperature of 55.83 and the highest of 72.94.

Table 5. Gelatinization profile

Storage Time (days)	To (°C)	Tc (°C)	Tp (°C)	Δ Hg (joule/g)
0	69,08	82,49	72,94	4,74
14	63,98	78,89	71,70	4,74
28	60,60	62,86	62,16	0,32
42	60,74	64,24	62,85	0,11
56	55,91	60,56	59,39	0,09
70	49,74	59,54	55,83	0,14

To: initial temperature, Tc: peak temperature, Tp: peak temperature, ΔHg: enthalpy

Initial temperature (To), peak temperature (Tp) and final temperature (Tc) associated with starch retrogradation and gelatinization enbutyment (ΔHg) decreased. The results of the analysis of the bread samples using the DSC test showed that the retrogradation peaks of the six samples were 72.94, 71.70, 62.16, 62.85, 59.39, and 55.83°C respectively. From the results of the retrogradation peak there was a significant decrease in samples 1 to 6, where the samples were in the storage treatment on day 0 to day 70. This decrease occurred due to the process of gelatinization and retrogradation.

The samples analyzed underwent pre-treatment in the form of steaming, so that they had undergone a gelatinization process. The starch granules are suspended in water and then heated, the granules will absorb water, if heated continuously the hydrogen bonds of the granules will weaken and gradually the starch granules will begin to expand. The development of starch granules occurs continuously until they break resulting in irreversible changes. Starch granules lose their properties and a gelatinization process occurs. In addition, the gelatinization temperature is also affected by the binding capacity between starch granules. The higher the gelatinization temperature of a type of starch, the higher the binding capacity of the starch granules.

The decrease in gelatinization temperature in the sample is closely related to the water content, texture, and volume of the sample. The effect of water content on starch gelatinization is influenced by the amylose content, which can also affect the crystallization of amylopectin [26]. The lower the water content in the sample, the faster the starch gelatinization process. This is because starch has hydrophilic groups that can absorb water, so if the water content in the sample is small, the absorption process will take place more quickly.

The lower the water content in the sample, the faster the starch gelatinization process. This is because starch has hydrophilic groups that can absorb water, so if the water content in the sample is small, the absorption process will take place more quickly [27]. The frozen storage temperature used was -18°C with storage times of 0, 14, 28, 42, 56 and 70 days. His research shows that longer storage will form more starch crystals with a higher level of perfection. The hardness and elasticity of the degraded starch gel increased during the initial stages of storage at constant temperature, but changed with longer storage. This is in line with the results of the DSC test in **Table 5**, namely the longer the storage, the gelatinization temperature continues to decrease so that the gelatinization proceeds faster.

The starch gelatinization process is also related to the physicochemical structure which can be seen from the SEM test. The decrease in gelatinization temperature indicates that the arrangement of the granule chain structure is increasingly disordered and damaged as a result of prolonged frozen storage. In addition, starch gelatinization causes hardening of the inside of the bread. Changes in starch granules are caused by enzyme activity which begins to intensify in degrading the cell wall, so that the cell wall is damaged. While the reduction in the air cavity of the bread is due to structural changes caused by the high recrystallization process which causes damage to the crumb structure. The recrystallization process increases with the length of freezing time. So bread with a longer freezing time can increase the number of free water molecules and gelatinization, because it has been reported that there has been a positive relationship between starch gelatinization and water content.

3.5 Appearance of crumbs of bread

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Microstructural testing of frozen bread using Scanning Electron Microscopy (SEM) was carried out to determine the physiology of frozen bread after storage changes were made on the 0th, 35th and 70th days. A comparison image of the microstructure of frozen bread with a magnification of 3000x with SEM can be seen in **Figure 1**.

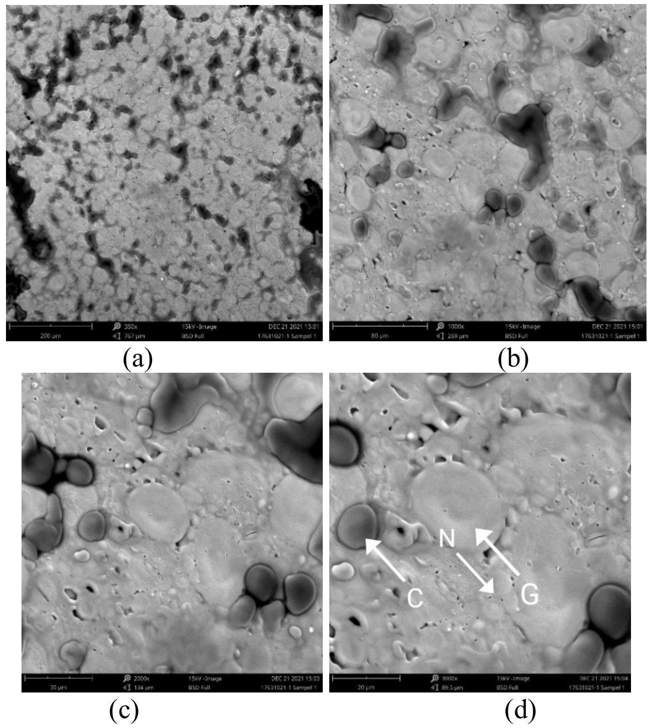
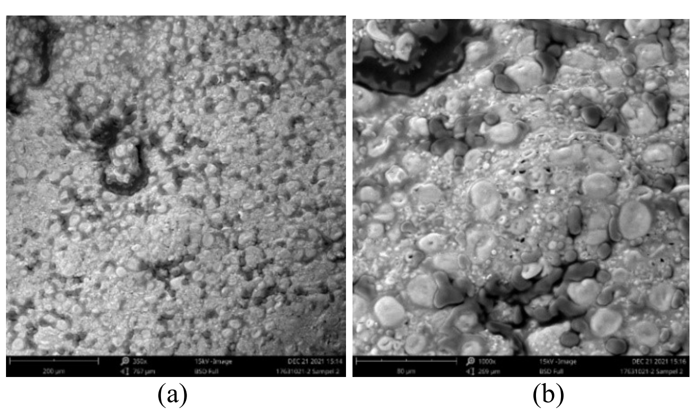
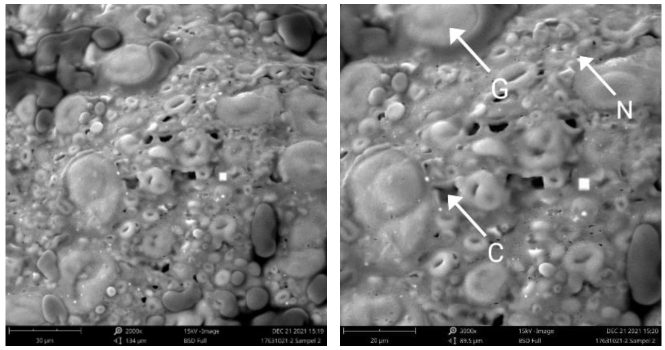


Figure 1. SEM test results on the surface of frozen bread storage day 0 (a) 350x magnification, (b) 1000x magnification, (c) 2000x magnification, (d) 3000x magnification, (C) Air voids, (N) protein network, (G) starch granules

Figure 1. shows a cross-section of bread on storage on day 0, where starch granules are visible surrounded by large air cavities. Some of the starch granules are still bound together and clustered on the cell wall. Starch granules have a shape that still looks round, regular, intact and homogeneous. After taking measurements, it was found that the air voids in the frozen bread samples on day 0 were 11 micrometers.

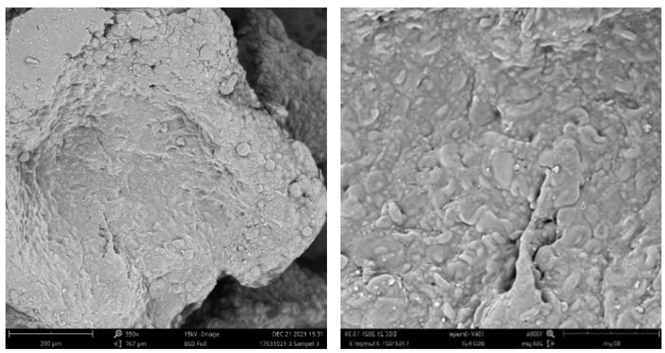
Figure 2. shows a change in the microstructure of the bread after storage on the 35th day. It is difficult to distinguish between starch granules and other components. The granules turn into a gel which is formed from starch gelatinization. Changes in the shape of the granules were seen in the 35th storage, where the granules began to separate and were not clustered and the air voids were getting smaller. It is known that the structure of the air cavity of the bread in the 35th storage after measurement is 5 micrometers.



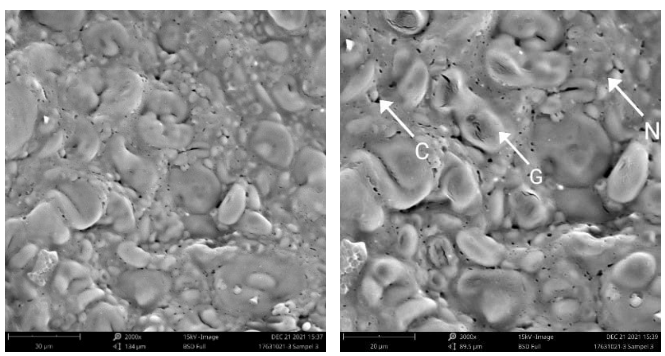


(c) (d)

Figure 2. SEM test results on the surface of frozen bread storage on the 35th day (a) 350x magnification, (b) 1000x magnification, (c) 2000x magnification, (d) 3000x magnification, (C) Air voids, (N) protein network, (G) starch granules



(a) (b)



(c) (d)

Figure 3. SEM test results on the surface of frozen bread storage on the 70th day (a) 350x magnification, (b) 1000x magnification, (c) 2000x magnification, (d) 3000x magnification, (C) Air voids, (N) protein network, (G) starch granules

Figure 3. shows changes in storage microstructure of bread after being stored on the 70th day. The gelatinization process causes starch granules and other components to be difficult to distinguish. The starch granules are no longer clustered and separate and start to have holes. In addition, some granules no longer have a regular round shape. The gelatinization process results in amylose and amylopectin molecules being released from the granules and will form a three-dimensional network structure [28]. Judging from the air cavity structure, bread with 70 days of storage showed a change in the air voids which were getting smaller. The size of the air cavity in the bread on the 70th day is 1 micrometer.

The change in starch granules was caused by enzyme activity which began to intensively degrade the cell wall, so that the cell wall was damaged. As a result, the granules are partially hydrolyzed on the surface of the granules, causing hollow starch granules. While the reduction in the air cavity of the bread is due to structural changes caused by the high recrystallization process which causes damage to the crumb structure. The recrystallization process increases with the length of freezing time, so that bread with a longer freezing time will experience more shrinkage of air voids. As a result of this process there is a change in size to about three times the size of the initial starch granule, causing the air cavity structure to be pressed.

3.6 Levels of pleasure

The sensory test in this study used the hedonic test method which included the level of preference for color, aroma, taste and overall preference based on a scale of 1-5 (a higher number indicates a very very like scale) using a panel of 30 untrained people (National Standardization Agency, 2006).

In this study, the sensory test was carried out as a preliminary study to determine the preference level of frozen bread products with different storage durations. The sensory test carried out was a hedonic ranking test which aimed to rank the panelist's preference level so that an assessment of bread with differences in frozen storage duration was obtained. Attributes tested in this study include taste, color, texture, softness, and overall. The level of preference for frozen bread after re-frying can be seen in Table 6.

Table 6. Preference level of frozen bread stored at -18°C after frying again

Storage Time (Days)	Favorite Score				
	Taste	Color	Texture	Softness	Overall
	4,27±0,76^{a}	4,33±0,92^{a}	4,57±0,77^{a}	4,33±0,92^{a}	4,57±0,62^{a}
14	4,33±0,80^{a}	4,20±0,96^{a}	4,40±0,72^{a}	4,17±0,90^{a}	4,51±0,62^{a}
28	4,13±1,00^{a}	4,23±0,77^{a}	4,33±0,75^{a}	4,23±0,77^{a}	4,39±0,61^{a}
42	4,30±0,88^{a}	4,30±0,95^{a}	4,30±0,87^{a}	4,30±0,95^{a}	4,43±0,88^{a}
56	4,07±0,90^{a}	3,90±1,06^{a}	4,33±0,60^{a}	3,93±1,08^{a}	4,46±0,73^{a}
70	4,30±0,75^{a}	4,37±0,91^{a}	3,87±0,90^{b}	4,37±0,80^{a}	3,89±1,06^{b}

Score 1=dislike very much, 2=dislike, 3=neutral, 4=like, 5=like very much

Description: the results followed by different letters in one line show a significant difference at the 95% confidence level.

Based on the results of Duncan's test, it is known that there is no significant difference between the long storage treatments on the preference level of frozen bread taste. The long-time treatment of frozen bread storage preferred by the panelists with the highest ranking was during the 14th storage with an average value of 4.33. The hedonic quality analysis of the taste produced is in the range of 4.07-4.33. This is consistent with the sensory test of taste parameters which showed no significant difference. This possibility occurs because the freezing process does not change the taste of the bread.

There is a significant difference between the long storage treatment on the preference level of frozen bread color. The results of Duncan's analysis of the color parameters of bread with different frozen storage times are in the range of 3.90-4.37. The highest value of the panelist's preferred color was in the 70th storage treatment with an average of 4.37. The panelist chose the sample on the 70th day as the sample with the highest average color value because the sample was considered to have a color that matched the panelist's preference. The 70th storage sample has a bright brownish yellow color so it is possible that the panelists prefer it compared to other samples. The sample with the lowest average value chosen by the panelists is in the 56th storage. This could be because the sample has a color that does not match the preference of the panelists. The sample on the 56th day was seen to have a less bright yellow and slightly brown color than the other samples so it was possible that the panelists didn't like it. Color can affect the value of product preference and products that are not suitable in color often get a low acceptance value [29]. However, the results of Duncan's sensory test on color parameters of frozen bread with different storage did not show significantly different results.

Significant difference between the long storage treatment on the preference level of frozen bread texture. The results of the texture sensory analysis are in the range of 3.87-4.57. Based on the results of Duncan's analysis, it was shown that the storage treatment on the 70th day of frozen bread had a significant effect on the texture characteristics of the bread with a texture of 17.44 ± 0.87N. This is presumably due to the starch retrogradation process. Storage of bread from day 0 to day 56 did not change significantly in terms of the panelists' assessment. Meanwhile, on the 70th day of storage, the panelists' assessments showed significantly different results. This proves that during frozen storage, a recrystallization process occurs which plays a role in the hardness of the breadcrumbs. Texture has an important influence on bakery products, for example from the level of softness, tenderness, and hardness. Texture is a sensation of pressure that can be observed with the mouth (when biting, chewing and swallowing) or demonstration with the fingers [30].

The results of Duncan's analysis of the softness parameter of bread with different frozen storage times are in the range of 3.93-4.37. The highest value of softness preferred by the panelists was in the 70th storage treatment with an average value of 4.37. This shows that the bread samples in the 70th storage have a softness that is in accordance with the panelists' preferences. This is also likely to occur due to a continuous increase in hardness on storage of bread samples from days 0 to 56. However, there was no significant increase in hardness from day 56 to day 70, so that the bread samples at storage 70 had a softer texture.

Based on the results of Duncan's test, it is known that there is a significant difference between the long storage treatments on the overall preference level of frozen bread. The results of the overall sensory analysis are in the range of 4.57-3.89. Based on the results of Duncan's analysis, it was shown that the storage treatment on the 70th day of frozen bread had a significant effect on the overall characteristics of the bread. Storage of bread from day 0 to day 56 did not change significantly in terms of the panelists' assessment. Meanwhile, on the 70th day of storage, the panelists' assessments showed significantly different results. This is in line with the results of the sensory assessment of taste, color and softness which were not significantly different for each prolonged frozen bread storage. This proves that during frozen storage, there was a process of changing the physicochemical structure of the bread which affected the overall rating of the frozen bread. Panelist sensory assessment of overall acceptance is the result of an assessment of all sensory parameters of taste, color, texture, tenderness, and overall.

4. CONCLUSION

Storage of frozen bread at a temperature (-18°C) until day 56 had an effect on the physical and chemical characteristics of the bread with the initial cooking of steaming, producing frozen bread that was highly preferred and not significantly different from the control (without freezing). Storage of frozen bread with pre-cooking by steaming for 0-70 days further reduces the water content, dissolved protein content and bread swelling rate, and increases the hardness level of the bread. The lower the gelatinization and enthalpy temperatures and the smaller the pore size of the re-cooked bread.

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