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FULL PAPER

Effect of addition of texturizer on the proximate content and texture properties of geblek, a cassava starch-based traditional food from Indonesia

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Abstract

Geblek is a traditional food from Kulonprogo, Yogyakarta that is made from cassava starch with characteristics including white color, shaped like the number of eight, tasty, and chewy. The chewy texture of geblek became tough when it is stored at room temperature and decreases the quality and consumer preference of geblek. The research aimed to evaluate the proximate and texture properties of geblek by adding hydrocolloids such as guar gum, xanthan gum, carrageenan, alginate, and a traditional texturizer such as dry grated coconut, for increasing the quality and preference of geblek. Raw and fried geblek were analyzed by nutritional composition and texture properties using Texture Analyzer (TA1, Lloyd Instruments). The addition of texturizers affected the nutritional composition and texture properties of geblek. The addition of xanthan gum to the geblek dough caused the highest increase in fat content, whereas the lowest was in the addition of carrageenan. The hardness of fried geblek ranged from 16.67 N (control) to 30.34 N (carrageenan) after frying then increasing 260.51% (alginate) to 660.94% (xanthan gum) after being stored for 24 hrs. The chewiness of geblek with the addition of dry grated coconut has a similar pattern to control. Storage of fried geblek at room temperature for 24 hrs increased the hardness, gumminess, springiness, chewiness, crispiness, and crunchiness, but decreased the cohesiveness and resilience. The best texture of deep-fried geblek after 24 hrs was found in geblek with the addition of 0.5% alginate.

1. Introduction

Indonesia has 17,504 islands but only about 6,000 islands are inhabited. The ethnic groups that inhabit the islands in Indonesia are around 300 ethnic groups or 1340 ethnic groups according to Indonesia Statistical Center Bureau (Ananta *et al*., 2014; Anonymous, 2017). There are 30 major ethnic groups in Indonesia and the Javanese are the largest ethnic group in Indonesia, with approximately 41% of the total population (Anonymous, 2017). The diversity of ethnic groups in Indonesia contributes to cultural diversity, including the diversity of food. Food is an identity of an ethnic group that is very easy to be recognized. Traditional food is defined as foods that are closely related to the ethnic group or community and are inherited from the older generation to the younger generation as part of a tradition. These are also known as local foods or culinary specialties (Pieniak *et al*., 2009).

Every province and region in Indonesia have some culinary specialties that are the hallmark or identity of the region. The Special Region of Yogyakarta is a province on Java Island that consists of four districts and one municipality. Kulonprogo is one of the districts on the west side of the Special Region of Yogyakarta and it is known for various tourist destinations and local products. Geblek is a traditional snack food from Kulonprogo made from *aci* or cassava starch (tapioca) in the form of wet or fresh with the addition of garlic as a seasoning and then fried. Geblek's sensory characteristics include white color, shape like the number of eight, savory taste, and chewy texture when warm. When the

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geblek is cold, the texture turns tough (Ratnaningsih *et al*., 2020).

Wet cassava starch as a major material in geblek if it is heated with the addition of liquid ingredients will undergo gelatinization so that the white raw cassava starch turns transparent. The gelatinized cassava starch may retrograde during cooling or storage. The change in the texture of geblek from chewy into tough is associated with the starch retrogradation process. Starch retrogradation is the process of combining and recrystallizing the gelatinized amylose and amylopectin fractions to form a more regular structure (Wang *et al*., 2015). The retrogradation process of starch-based food products is often undesirable because it can reduce the quality, shelf life, and consumer acceptance. This process is also found in geblek which becomes tough when it is cold, causing a decrease in quality, shelf life, and the level of consumer acceptance.

The prevention of the retrogradation process in starchy foods can be done in several ways, such as using hydrocolloids. Hydrocolloids are long-chain polymers (in the form of polysaccharides or proteins) that are characterized by the ability to form viscous dispersions and/or gels when dispersed in water (Milani and Maleki, 2012). The application of hydrocolloids in food products is as thickeners, gelling agents, emulsifiers, stabilizers, coatings, source of dietary fiber, and others. Hydrocolloids can affect the rheological properties of the food system and were commonly used to modify the texture of various food products (Funami, 2011). Hydrocolloids also can reduce the oil uptake in deep-fat-fried foods (Liberty *et al*., 2019; Al-Asmar *et al*., 2020; Yang *et al*., 2020; Martinez-Pineda *et al*., 2021). Some examples of hydrocolloids that are widely used in food products include agar, alginate, carrageenan, cellulose derivatives, chitosan, gum, pectin, starch, and gelatin (Milani and Maleki, 2012; Zhang *et al*., 2021). The addition of hydrocolloids in geblek dough is presumed to prevent the retrogradation process of cassava starch and for oil uptake reduction after deep frying so the texture of geblek remains chewy and does not turn tough and is less oily.

Recently, research on geblek is very limited and only focuses on increasing nutrient content, such as protein using fish (Al Qodri, 2017) and dietary fiber (Meiyana *et al*., 2018). Prevention of retrogradation in starchy foods using hydrocolloids have been published, including gluten free steamed cake from black waxy rice flour (Itthivadhanapong *et al*., 2016); bread from a mixture of modified cassava flour, yellow corn flour, and corn starch (Eduardo *et al*., 2016), noodles from glutinous rice flour (Cai *et al*., 2016), corn starch (Fu and BeMiller, 2017), noodles from a mixture of modified cassava flour, rice flour, and cornflour (Ratnawati and Afifah, 2018), muffin (Masmoudi *et al*., 2020), low fat banana chips (Paramasivam *et al*., 2021), and potato steamed bread (Ma *et al*., 2022). However, the retrogradation process in geblek has never been published, including the method of preventing its retrogradation by using texturizer.

Therefore, the objective of the research was to evaluate the nutritional composition and texture profile of geblek with the addition of various texturizers such as hydrocolloids (guar gum, xanthan gum, carrageenan, and alginate) and other texturizers such as dry grated coconut. We observed the geblek raw, deep-fried geblek, and after stored for 24 hrs at room temperature for understanding the effect of texturizers on the nutritional composition and texture properties of geblek. Scientific information obtained from this study is very necessary to understand the mechanism and prevention of retrogradation and reduction of oil uptake in traditional starch-based foods, such as geblek. The results of this study also contribute to improving the quality, shelf life, and level of consumer acceptance of traditional foods.

2. Materials and methods

2.1 Materials

Wet cassava starch was obtained from CV Patimurni Andani as a geblek producer in Kulonprogo district. Texturizers such as guar gum, xanthan gum, carrageenan, alginate, and dry grated coconut, were purchased from a local market.

2.2 Processing geblek

The geblek was processed according to Ratnaningsih *et al*. (2020). Wet cassava starch (3 kg) was mixed manually with two seasonings such as 10% (w/w) garlic and 5% (w/w) salt, and various texturizers until a homogeneous mixture was formed. Based on our trial before, the addition of texturizer varied from 0.5% for alginate, 1% for xanthan gum, 2% for guar gum and carrageenan, and 2.5% for dry grated coconut (w/w based on the weight of wet cassava starch). The dough mixture was packed using a food-grade plastic bag and then boiled in water for 30 mins using a boiling pot. After that, the dough was mixed again using a vertical mixer to form a smooth and non-sticky dough. The geblek dough was grounded using a meat grinder and ready to be formed by hand like the number of eight. After formed, the geblek was deep-fried until cooked (140-150ºC for 5-7 mins) and then drained the oil using paper towels, cooled, and stored using a plastic container at room temperature for 24 hrs.

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2.3 Determination of nutritional composition

Nutritional composition was analyzed for their moisture (Method No. 925.09), crude protein (Nx6.25) (Method No. 920.87), total lipid (Method No. 920.39) with petroleum ether as a solvent, and ash content (Method No. 923.03) following the standard methods of AOAC (2005).

2.4 Determination of texture profile

Texture analyzer (TA1, Lloyd Instruments) was used to determine the texture of geblek. Sample (one piece of geblek, 6×3×1 cm^3) was pressed with a probe to achieve 50% of its height. The test speed was 0.5 mm/s, wait time 0.5 s, preload/stress 1 N, and preload/stress speed 300 mm/min. Force-time graphs of the texture analyzer were shown in Figure 1. Several texture parameters were observed, such as hardness, adhesiveness, cohesiveness gumminess, crispiness, springiness, and resilience of samples. The description and formula of texture parameters were explained in Table 1 (Bland *et al*., 2018).

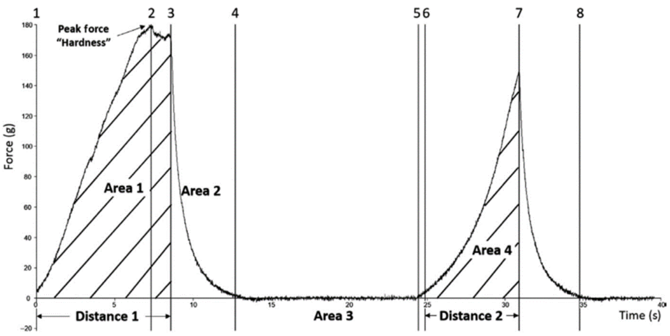

Figure 1. Texture profile analysis force-time graph showing anchor points used to measure attributes. This was a nonrepresentative sample that showed a separation between anchors 2 and 3 (Bland *et al*., 2018)

2.5 Statistical analysis

All the experiments were performed in duplicate, and experimental data also were analyzed using ANOVA and expressed as mean ± standard deviation (SD). A Duncan's multiple range test was conducted to assess significant differences among experimental mean values ($p<0.05$). All statistical analyses were conducted using SPSS version 26 for Windows.

3. Results and discussion

3.1 Effect of texturizer on the nutritional composition of geblek

Nutritional composition of geblek with the addition of texturizer before and after deep frying was shown in Table 2. Geblek is consumed after the deep-frying process using vegetable oils, such as palm oil and coconut oil. Deep-fat frying can be defined as a process of cooking foods by immersing them in edible oil or fat at a temperature above the boiling point of water, where the edible oil or fat serves as the heat transfer medium (Liberty *et al*., 2019; Martinez-Pineda *et al*., 2021). Deep -fat frying usually uses relatively high temperatures for short times and is applied to prepare various kinds of foods with unique textures, flavors, and appearances (Wang *et al*., 2021).

The addition of texturizer on the geblek dough affects the nutritional composition significantly, particularly in the moisture and lipid contents. Deep frying decreased the moisture content of fried geblek by 21-31% compared to its raw. Wang *et al*. (2021) explained that during frying, mass and heat transfer processes occur simultaneously where heat and oil move into the food, while moisture moves out. Heat is transferred from the heated oil to the surface of the food by convection. As the food gets heated, the heat is transferred into the interior of the product by conduction during which the moisture within gets heated to boiling temperature and forms steam (Liberty *et al*., 2019). During frying, interactions between oil and the product resulted in numerous physical, chemical, and structural changes (Norizzah *et al*., 2016). The structure and physicochemical properties of starch are affected by the heat and mass transfer processes during frying, thus changing the final quality of starch-based foods (Wang *et al*., 2021).

Table 1. Description and formula of texture attributes.

Attributes	Description	Formula
Hardness	The peak force that occurs during the first 50% compression.	Force at anchor 2
Gumminess	Mutually exclusive with chewiness since a product would not be both a semi-solid and a solid at the same time.	Hardness × Cohesiveness
Chewiness	Chewiness applies only to solid products.	Gumminess × Springiness
Cohesiveness	The area of work during the second compression divided by the area of work during the first compression.	Area 4/Area 1
Springiness	How well a product physically springs back after it has been deformed during the first compression and has been allowed to wait for the target wait time between strokes.	Distance 2 / Distance 1
Resilience	How well a product "fights to regain its original height" and is measured on the withdrawal of the first penetration, before the waiting period is started.	Area 2/Area 1

Source: Bland *et al*. (2018) and Texture Technologies Corp (2021).

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Table 2. Nutritional composition of geblek before and after deep-frying.

Treatment	Moisture	Ash	Protein	Lipid	Carbohydrate (by difference)
Control					
Raw	44.21±0.01[d]	2.10±0.03[a]	0.42±0.11[c]	0.28±0.09[b]	52.99±0.04[b]
Deep-fried	33.83±0.86[B]	2.23±0.05[A]	1.11±0.01[B]	4.00±0.21[B]	58.83±0.60[C]
Alginate 0.5%					
Raw	44.74±0.00[c]	1.91±0.04[a]	0.57±0.12[b]	0.24±0.04[b]	52.54±0.12[b]
Deep-fried	30.70±0.25[D]	2.03±0.01[B]	0.81±0.06[C]	4.28±0.09[B]	62.19±0.40[A]
Xanthan gum 1%					
Raw	43.02±0.04[e]	2.07±0.05[a]	0.18±0.00[d]	0.12±0.02[d]	54.62±0.11[a]
Deep-fried	32.15±0.13[C]	2.16±0.01[B]	0.73±0.03[D]	2.66±0.01[D]	62.30±0.49[A]
Carrageenan 2%					
Raw	43.26±0.05[e]	1.88±0.26[a]	0.41±0.11[c]	1.41±0.02[a]	53.04±0.12[b]
Deep-fried	31.83±0.12[C]	2.68±0.29[A]	0.97±0.02[B]	3.76±0.12[C]	60.77±0.02[B]
Guar gum 2%					
Raw	47.55±0.06[a]	1.65±0.01[b]	0.82±0.00[a]	0.19±0.03[c]	49.79±0.02[d]
Deep-fried	37.47±0.45[A]	1.66±0.07[C]	1.42±0.01[A]	2.33±0.05[D]	57.12±0.44[D]
Dry grated coconut 2.5%					
Raw	45.37±0.01[b]	2.05±0.16[a]	0.33±0.00[c]	0.33±0.03[b]	51.93±0.17[c]
Deep-fried	33.58±0.01[B]	1.73±0.00[C]	0.99±0.01[B]	5.12±0.40[A]	58.58±0.43[C]

Values are presented as mean±SD. Values with different lowercase superscripts within the same column are statistically significantly different ($p < 0.05$) among raw samples while values with different uppercase superscripts within the same column are statistically significantly different ($p < 0.05$) among deep-fried samples.

Generally, the process of oil absorption during deep-fat frying consists of three mechanisms, including water replacement, cooling-phase effect, and a surface-active agent. The water replacement mechanism primarily describes the uptake of oil in the relatively large pores of fried foods formed because of moisture loss. The mechanism of the cooling-phase effect describes the significant amount of oil that is absorbed when the food is removed from the fryer. In the surface-active mechanism, there was an opinion that chemical reactions such as polymerization, hydrolysis, and oxidation occur during the frying process to form volatile and non-volatile compounds resulting in a decrease in surface tension and an increase in oil uptake (Liberty *et al*., 2019; Ching *et al*., 2021). Oil uptake of fried food products is affected by many factors, such as oil quality, frying temperature and duration, the product's shape, moisture, solids, fat or protein contents and porosity, pre-frying treatments (drying, blanching), and coating (Varela and Fiszman, 2011; Kurek *et al*., 2017; Oke *et al*., 2018).

Hydrocolloids can reduce the excessive oil uptake due to thermogelling properties, decrease surface permeability, and build a barrier against oil uptake (Ching *et al*., 2021). Kurek *et al*. (2017) explained that hydrocolloids can reduce the oil content of deep-fat-fried food either acting as a lipid barrier when formed as thin films and dried before frying or by their gelation properties during heating. The addition of hydrocolloids, such as guar gum and carrageenan, in geblek dough, can reduce oil uptake in deep-fried geblek, whereas xanthan gum and alginate can increase higher oil uptake. Carrageenan and guar gum have been demonstrated to be effective in reducing oil absorption during deep frying of geblek due to they increased the lipid content around 166% and 1124%, respectively. These results are in line with Varela and Fiszman (2011) reported that xanthan gum was not effective to decrease oil uptake in sev (a fried product prepared from chickpea flour). They also reported the effectiveness of hydrocolloids decreased in oil uptake in sev as follows: gum arabic > carrageenan > gum karaya > guar gum. Meanwhile, these results are different from the previous studies, for example in the addition of 1% xanthan gum into the batter in banana fritters (Norizzah *et al*., 2016) and sponge cake (Noorlaila *et al*., 2017), 1.5% xanthan gum in the casing of samosa (Sakhale *et al*., 2011), and the addition of 2% of guar gum in non-wheat noodles (Ratnawati and Afifah, 2018). The use of guar gum in fried products is around 0.5-1.0% for reducing oil absorption (Thombare *et al*., 2016). The reduction of oil uptake in the deep-fried geblek with the addition of hydrocolloids is associated with moisture content. After the frying process, the higher moisture loss can increase the oil absorption in deep-fried geblek. Addition 0.5% alginate in the dough geblek showed the highest moisture loss (14.04%) after frying so it has the highest lipid content compared to the other hydrocolloids. Hydrophilic groups of hydrocolloids, such as guar gum and xanthan gum, have a good water-binding capacity with hydrogen bonds to minimize moisture evaporation during deep-frying (Ching *et al*., 2021). Furthermore, they can form a thin film that more brittle and stronger surface with fewer

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voids to prevent water and steam escape from the porous surface (Kurek *et al*., 2017). Liberty *et al*. (2019) also explained that the water replacement mechanism which majorly explains oil uptake of comparatively big pores in the fried food formed because of moisture loss as a strong relationship between moisture loss with oil absorption during the frying process. The increasing lipid content of deep-fried geblek was from 166% (carrageenan) to 2000% (xanthan gum). Therefore, the effectiveness of texturizer in reduction of the lipid content of deep-fried geblek in the following order: carrageenan > guar gum > dry grated coconut > alginate > xanthan gum. The addition of alginate and xanthan gum is not effective for the reduction of oil uptake during the deep-frying process. Meanwhile, the addition of 2.5% dry grated coconut produced geblek with the highest lipid content. The lipid content of dry grated coconut was around 67.5% (Polii, 2017) that increasing the lipid content of geblek. The lower lipid content in fried products, such as geblek with the addition of 2% guar gum and 1% xanthan gum, indicates healthier food products.

The addition of hydrocolloids also significantly affected the protein content of deep-fried geblek. Hydrocolloids from seaweeds (alginate and carrageenan) and bacterial exopolysaccharides (xanthan gum) have no protein in their nutritional composition. However, the addition of hydrocolloids and dry grated coconut increased the protein content of deep-fried geblek around 41-300%. Guar gum is a gel-forming galactomannan from the endosperm of locust bean (*Cyamopsis tetragonolobus*) and it contains 5-6% protein content (Mudgil *et al*., 2014; Thombare *et al*., 2016).

3.2 Effect of texturizer on the texture properties of geblek

Before being consumed, geblek was deep-fried at high temperature (140-150ºC) for short times (3-5 mins) using vegetable oils, such as palm oil. This process can lead to the changes of unique textures, flavors, and appearances of geblek. The texture is one of the most important quality attributes of geblek and it contributes to consumer acceptance. The addition of texturizer to geblek dough aims to produce deep-fried geblek with a chewy texture for several hrs after frying to increase consumer acceptance. Texture is important in terms of both food palatability and the safety of eating (Funami, 2011).

Texture properties of geblek with the addition of texturizer from hydrocolloids and dry grated coconut were shown in Figure 2 to Figure 7. The hardness of geblek was significantly affected by the addition of a texturizer (Figure 2). The hardness of fried geblek ranged from 16.67 N (control) to 30.34 N (carrageenan) after frying then increasing 260.51% (alginate) to 660.94% (xanthan gum) after being stored for 24 hrs. Hardness is a force exerted on an object until it changes shape (deformation) and it shows the maximum peak at the first pressure or the first bite (DeMan, 1999). The highest hardness of raw geblek was shown at the addition of 2% carrageenan, and the lowest was at the addition of 2.5% dry grated coconut. This result indicates that the hardness of raw geblek may correlate with moisture content as reported by previous studies (Aminullah *et al*., 2020). After frying, the hardness of deep-fried geblek decreased when compared to its raw. However, the hardness of deep-fried geblek significantly increased after storage for 24 hrs at room temperature with the highest hardness was found at the addition of 2% carrageenan and the lowest was at the addition of 0.5% alginate. The increasing of hardness in deep-fried geblek after storage 24 hrs exhibited retrogradation process continue although dough has been added with texturizers. Carrageenan and xanthan gum cannot be able to prevent retrogradation in deep-fried geblek. Otherwise, the addition of alginate, dry grated coconut, and guar gum produced geblek with lower hardness than control.

Gumminess and chewiness of geblek with the addition of texturizers also showed a similar pattern with hardness (Figure 3 and Figure 4). Gumminess is mutually exclusive with chewiness since a product would not be both a semi-solid and a solid at the same time (Texture Technologies Corp., 2021). Gumminess is defined as the result of the hardness value multiplied by the cohesiveness value in semisolid foodstuffs with low hardness values but high cohesive values (Indiarto *et al*., 2012; Texture Technologies Corp., 2021). The chewiness is defined as the result of calculating the gumminess value multiplied by the springiness value. The chewiness is the most difficult texture characteristic to measure precisely because it involves compressing, shearing, piercing, grinding, tearing, and cutting along with lubrication by saliva at a given body temperature (DeMan, 1999; Yang *et al*., 2020). The highest gumminess and chewiness of raw geblek was shown at the addition of 2% carrageenan, and the lowest was at the addition of 2.5% dry grated coconut. Gumminess and chewiness of geblek increased after deep-frying and storage for 24 hrs with the highest was at the addition of 2% carrageenan and the lowest was at the addition of 0.5% alginate.

The cohesiveness of raw geblek and after deep-fried and storage showed significantly different (Figure 5). Cohesiveness is the strength of internal bonds to form a

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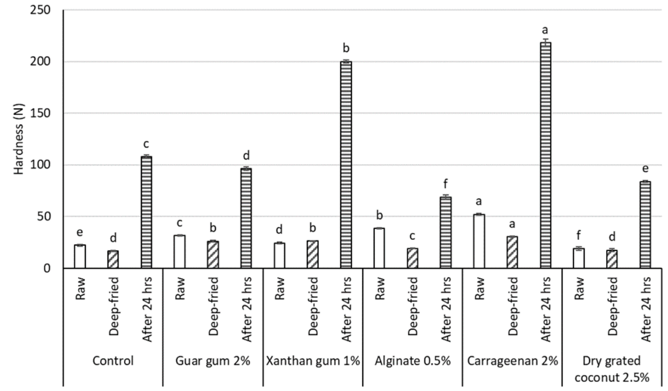

Figure 2. Effect of texturizers on the hardness of geblek

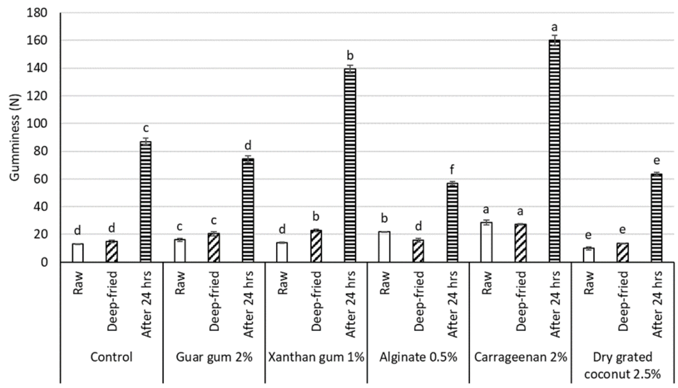

Figure 3. Effect of texturizers on the gumminess of geblek

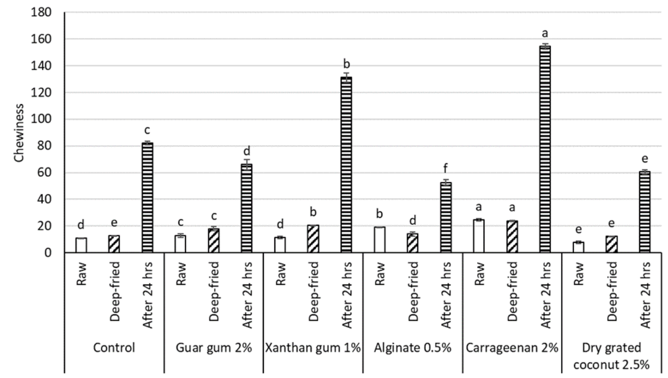

Figure 4. Effect of texturizers on the chewiness of geblek

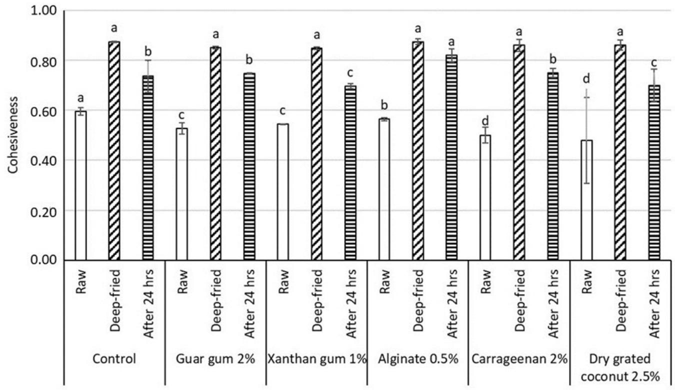

Figure 5. Effect of texturizers on the cohesiveness of geblek

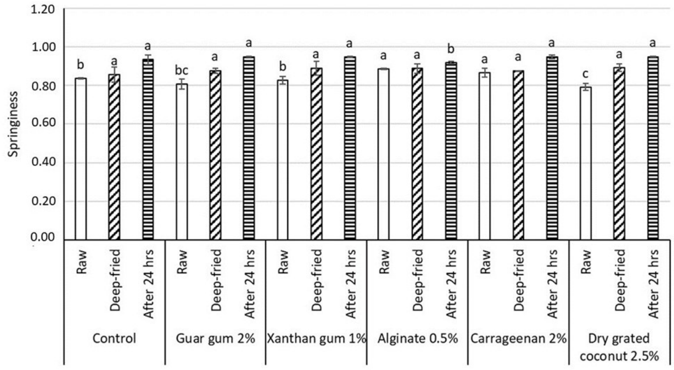

Figure 6. Effect of texturizers on the springiness of geblek

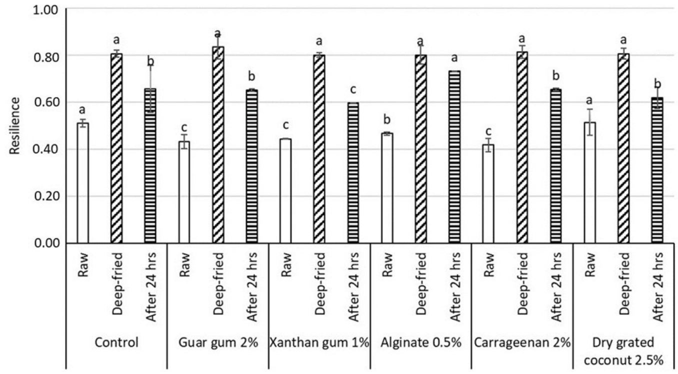

Figure 7. Effect of texturizers on the resilience of geblek

body of product (Texture Technologies Corp., 2021). Cohesiveness is also defined as the ratio of the area of pressure during the second compression to the first compression and has no unit (Bland *et al*., 2018). The highest cohesiveness of raw geblek was at control, and the lowest was at the addition of dry grated coconut. The cohesiveness of geblek increased after deep-frying and showed no significant difference. After storage, the cohesiveness of geblek decreased with the highest was at the addition of 0.5% alginate and the lowest was at the addition of xanthan gum and dry grated coconut.

The springiness of geblek increased significantly and has a similar trend in all samples (Figure 6). Springiness (elasticity) is a rheological property that describes the ability of an object to return to its original shape after changing shape (deformation). Springiness is now expressed as a ratio or percentage of a product's original height. Springiness is measured several ways, but most typically, by the distance of the detected height during the second compression divided by the original compression distance. Springiness can also be defined as the recovery time between the end of the first bite and the beginning of the second bite (DeMan, 1999; Indiarto *et al*., 2012; Texture Technologies Corp., 2021). After frying and storage, the springiness of geblek has not significantly different.

The resilience of geblek showed a similar pattern with cohesiveness (Figure 7). Resilience is a measurement of the rate of recovery of the sample deformation in terms of speed and strength. The measurement is taken as the ratio of the area of the first turning point across the x-axis and the resulting area of the first compression cycle. Resilience is how well a product "fights to regain its original height" (Texture Technologies Corp., 2021). The resilience of all samples geblek has a similar value after deep-frying but decreases after 24 hrs storage. The highest resilience after storage was found in the addition of 0.5% alginate, while the lowest was in the addition of 1% xanthan gum.

4. Conclusion

The addition of texturizers to the geblek dough significantly affected the moisture, lipid, and protein contents, and also the texture properties of deep-fried geblek. The reduction of oil uptake in the deep-fried geblek with the addition of hydrocolloids is associated with moisture content. The effectiveness of texturizer in reduction of the lipid content of deep-fried geblek in the following order: carrageenan > guar gum > dry grated coconut > alginate > xanthan gum. However, the best texture of deep-fried geblek after 24 hrs was found in geblek with the addition of 0.5% alginate and 2.5% dry grated coconut. Our finding revealed that hydrocolloids (alginate) and dry grated coconut could prevent retrogradation of geblek after storage at room temperature, but they contained more lipid content, so further research is needed to reduce oil uptake of geblek or starch-based food in the future.

Conflict of interest

The authors declare no conflict of interest.

Acknowledgments

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References

Al-Asmar, A., Giosafatto, C.V.L., Sabbah, M. and Mariniello, L. (2020). Hydrocolloid-based coatings with nanoparticles and transglutaminase crosslinker as innovative strategy to produce healthier fried kobbah. *Foods*, 9(6),698. https://doi.org/10.3390/foods9060698

Al Qodri, M. (2017). Penambahan ikan rucah terhadap karakteristik mutu geblek. Indonesia: Universitas Lampung, BSc Thesis. [In Bahasa Indonesia].

Aminullah, A., Daniel, D. and Rohmayanti, T. (2020). The texture and hedonic profiles of pempek lenjer made from local commodities of bogor taro flour (*Colocasia esculenta* L. Schott) and African catfish (*Clarias gariepinus*). *Jurnal Teknologi and Industri Hasil Pertanian*, 25(1), 7–18. [In Bahasa Indonesia].

Ananta, A., Arifin, E.N. and M.Sairi, H. (2014). A New Classification of Indonesia's Ethnic Groups. ISEAS Working Paper No. 1. Retrieved from ISEAS website: https://www.iseas.edu.sg/images/pdf/iseas_working_papers_2014_1.pdf

Anonymous. (2017). Ethnic groups. Retrieved from Indonesia website: https://indonesia.go.id/profil/suku-bangsa/kebudayaan/suku-bangsa#:~:text=Indonesia memiliki lebih dari 300, mencapai 41%25 dari total populasi. [In Bahasa Indonesia].

AOAC (Association of Official Analytical Chemist). (2005). AOAC: Official Methods of Analysis. Vol. 1. Virginia, USA: AOAC Inc.

Bland, J.M., Bett-Garber, K.L., Li, C.H., Brashear, S.S., Lea, J.M. and Bechtel, P.J. (2018). Comparison of sensory and instrumental methods for the analysis of texture of cooked individually quick frozen and fresh-frozen catfish fillets. *Food Science and Nutrition*, 6 (6), 1692–1705. https://doi.org/10.1002/fsn3.737

Cai, J., Chiang, J.H., Tan, M.Y.P., Saw, L.K., Xu, Y. and Ngan-Loong, M.N. (2016). Physicochemical properties of hydrothermally treated glutinous rice flour and xanthan gum mixture and its application in gluten-free noodles. *Journal of Food Engineering*, 186, 1–9. https://doi.org/10.1016/j.jfoodeng.2016.03.033

Ching, L.W., Zulkipli, N. 'Afifah M., Muhamad, I. I., Marsin, A.M., Khair, Z. and Anis, S.N.S. (2021). Dietary management for healthier batter formulations. *Trends in Food Science and Technology*, 113, 411–422. https://doi.org/10.1016/j.tifs.2021.03.054

DeMan, J.M. (1999). Principles of food chemistry. Food Science Text Series. 3rd ed. New York, USA: Springer. https://doi.org/10.1007/978-1-4614-6390-0

Eduardo, M., Svanberg, U. and Ahrné, L. (2016). Effect of hydrocolloids and emulsifiers on the shelf-life of composite cassava-maize-wheat bread after storage. *Food Science and Nutrition*, 4(4), 636–644. https://doi.org/10.1002/fsn3.326

Fu, Z. and BeMiller, J.N. (2017). Effect of hydrocolloids and salts on retrogradation of native and modified maize starch. *Food Hydrocolloids*, 69, 36–48. https://doi.org/10.1016/j.foodhyd.2017.01.023

Funami, T. (2011). Next target for food hydrocolloid studies: Texture design of foods using hydrocolloid technology. *Food Hydrocolloids*, 25(8), 1904–1914. https://doi.org/10.1016/j.foodhyd.2011.03.010

Indiarto, R., Nurhadi, B. and Subroto, E. (2012). Kajian Karakteristik Tekstur (Texture Profil Analysis) Dan Organoleptik Daging Ayam Asap Berbasis Teknologi Asap Cair Tempurung Kelapa. *Jurnal Teknologi Hasil Pertanian*, 5(2), 106–116. [In Bahasa Indonesia].

Itthivadhanapong, P., Jantathai, S. and Schleining, G. (2016). Improvement of physical properties of gluten -free steamed cake based on black waxy rice flour using different hydrocolloids. *Journal of Food Science and Technology*, 53(6), 2733–2741. https://doi.org/10.1007/s13197-016-2245-5

Kurek, M., Ščetar, M. and Galić, K. (2017). Edible coatings minimize fat uptake in deep fat fried products: A review. *Food Hydrocolloids*, 71, 225–235. https://doi.org/10.1016/j.foodhyd.2017.05.006

Liberty, J.T., Dehghannya, J. and Ngadi, M.O. (2019). Effective strategies for reduction of oil content in deep-fat fried foods: A review. *Trends in Food Science and Technology*, 92, 172–183. https://doi.org/10.1016/j.tifs.2019.07.050

Ma, M., Mu, T., Sun, H. and Zhou, L. (2022). Evaluation of texture, retrogradation enthalpy, water mobility, and anti-staling effects of enzymes and hydrocolloids in potato steamed bread. *Food Chemistry*, 368, 130686. https://doi.org/10.1016/j.foodchem.2021.130686

Martinez-Pineda, M., Yague-Ruiz, C. and Vercet, A. (2021). Frying conditions, methyl cellulose, and k-carrageenan edible coatings: Useful startegies to reduce oil uptake in fried mushrooms. *Foods*, 10, 1694. https://doi.org/10.3390/foods10081694

Masmoudi, M., Besbes, S., Bouaziz, M.A., Khlifi, M., Yahyaoui, D. and Attia, H. (2020). Optimization of acorn (*Quercus suber* L.) muffin formulations: Effect of using hydrocolloids by a mixture design approach. *Food Chemistry*, 328, 127082. https://doi.org/10.1016/j.foodchem.2020.127082

Meiyana, K.T., Dewi, D.P. and Kadaryati, S. (2018). Kajian sifat fsik dan serat pangan pada gèblek substitusi daun kelor (*Moringa oleifera* L.). *Ilmu Gizi Indonesia*, 1(2), 127. https://doi.org/10.35842/ilgi.v1i2.38 [In Bahasa Indonesia].

Milani, J. and Maleki, G. (2012). Hydrocolloids in Food Industry. In Valdez, B. (Ed.) Food Industrial Processes - Methods and Equipment. InTech Open E-Book. https://doi.org/10.5772/32358

Mudgil, D., Barak, S. and Khatkar, B.S. (2014). Guar gum: Processing, properties and food applications - A Review. *Journal of Food Science and Technology*, 51(3), 409–418. https://doi.org/10.1007/s13197-011-0522-x

Noorlaila, A., Hasanah, H.N., Yusoff, A., Sarijo, S. H. and Asmeda, R. (2017). Effects of xanthan gum and HPMC on physicochemical and microstructure properties of sponge cakes during storage. *Journal of Food Science and Technology*, 54(11), 3532–3542. https://doi.org/10.1007/s13197-017-2810-6

Norizzah, A.R., Junaida, A.R. and Maryam 'Afifah, A.L. (2016). Effects of repeated frying and hydrocolloids on the oil absorption and acceptability of banana (*Musa acuminate*) fritters. *International Food Research Journal*, 23(2), 694–699.

Oke, E.K., Idowu, M.A., Sobukola, O.P., Adeyeye, S.A.O. and Akinsola, A.O. (2018). Frying of Food: A Critical Review. *Journal of Culinary Science and Technology*, 16(2), 107–127. https://doi.org/10.1080/15428052.2017.1333936

Paramasivam, S.K., David, A.K., Marimuthu Somasundaram, S., Suthanthiram, B., Shiva, K.N. and Subbaraya, U. (2022). Influence of food hydrocolloids on the structural, textural and chemical characteristics of low-fat banana chips. *Food Science and Technology International,* 28(3), 203-215. https://doi.org/10.1177/10820132211003708

Pieniak, Z., Verbeke, W., Vanhonacker, F., Guerrero, L. and Hersleth, M. (2009). Association between traditional food consumption and motives for food choice in six European countries. *Appetite*, 53(1), 101–108. https://doi.org/10.1016/j.appet.2009.05.019

Polii, F.F. (2017). Pengaruh Substitusi Tepung Kelapa Terhadap Kandungan Gizi dan Sifat Organoleptik Kue Kering. *Buletin Palma*, 18(2), 91–98. [In Bahasa Indonesia].

Ratnaningsih, N., Devi, K.M. and Sugati, D. (2020). The quality and quantity improvement efforts for Geblek Kulonprogo as a millennial healthy snack. *Journal of Physics: Conference Series*, 1446, 012069. https://doi.org/10.1088/1742-6596/1446/1/012069

Ratnawati, L. and Afifah, N. (2018). Pengaruh Penggunaan Guar Gum, Carboxymethylcecllulose (CMC) dan Karagenan terhadap Kualitas Mi yang Terbuat dari Campuran Mocaf, Tepung Beras dan Tepung Jagung. *Pangan*, 27(1), 43–54. [In Bahasa Indonesia].

Sakhale, B.K., Badgujar, J.B., Pawar, V.D. and Sananse, S.L. (2011). Effect of hydrocolloids incorporation in casing of samosa on reduction of oil uptake. *Journal of Food Science and Technology*, 48(6), 769–772. https://doi.org/10.1007/s13197-011-0333-0

Texture Technologies Corp. (2021). Overview of Texture Profile Analysis (TPA). Retrieved from Texture Technologies website: https://texturetechnologies.com/resources/texture-profile-analysis#tpa-measurements

Thombare, N., Jha, U., Mishra, S. and Siddiqui, M. Z. (2016). Guar gum as a promising starting material for diverse applications: A review. *International Journal of Biological Macromolecules*, 88, 361–372.

https://doi.org/10.1016/j.ijbiomac.2016.04.001

Varela, P. and Fiszman, S.M. (2011). Hydrocolloids in fried foods. A review. *Food Hydrocolloids*, 25(8), 1801–1812. https://doi.org/10.1016/j.foodhyd.2011.01.016

Wang, S., Li, C., Copeland, L., Niu, Q. and Wang, S. (2015). Starch Retrogradation: A Comprehensive Review. *Comprehensive Reviews in Food Science and Food Safety*, 14(5), 568–585. https://doi.org/10.1111/1541-4337.12143

Wang, Y., Wu, X., McClements, D.J., Chen, L., Miao, M. and Jin, Z. (2021). Effect of new frying technology on starchy food quality. *Foods*, 10(8), 1852. https://doi.org/10.3390/foods10081852

Yang, X., Li, A., Li, X., Sun, L. and Guo, Y. (2020). An overview of classifications, properties of food polysaccharides and their links to applications in improving food textures. *Trends in Food Science and Technology*, 102, 1–15. https:// doi.org/10.1016/j.tifs.2020.05.020

Zhang, N., Zhou, Q., Fan, D., Xiao, J., Zhao, Y., Cheng, K.W. and Wang, M. (2021). Novel roles of hydrocolloids in foods: Inhibition of toxic Maillard reaction products formation and attenuation of their harmful effects. *Trends in Food Science and Technology*, 111, 706–715. https://doi.org/10.1016/j.tifs.2021.03.020

