JFBE 4(1): 94-98, 2021

Journal of Food and Bioprocess Engineering

Journal homepage: https://jfabe.ut.ac.ir

Original research

Physicochemical, textural and sensorial properties of cocoa sponge cake formulated with xanthan gum during shelf-life

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ABSTRACT

In this paper, it was aimed to investigate physicochemical and sensorial characteristics of cocoa sponge cake containing xanthan gum during maintenance interval. To reduce the stiffness of the texture, preserve moisture content and suitable sensorial properties during the shelf-life of these types of products using gums can be necessary. The treatments were included 0, 0.1, 0.2 and 0.3% xanthan gum. Moisture, ash, protein, volume values, texture and sensory evaluation of cake were evaluated and for investigating shelf-life, cakes were stored up to 30 days. It demonstrates xanthan gum improves the characteristics of the cake during storage. Using 0.2% of xanthan gum increased volume value (126 ml/g at first day). Moreover, a decreasing trend was observed up to 0.2% gum in hardness, cohesiveness, springiness, gumminess and chewiness of cake. In terms of sensory evaluation, no significant difference was observed between most of the treatment factors (only the aroma of control was significantly different from the treatments)**.** So using xanthan gum in the cake formulation has economical positive aspect and affects quality of final product and its nutritional properties.

Keywords: Hydrocolloid; Baking product; Storage; Qualitative characteristics

Received 28 February 2021; Revised 13 April 2021; Accepted 17 April 2021

1. Introduction

The quality of the produced bakery foods requires the use of a number of additives, improvers, stabilizers and thickeners that ensure consistent quality of food products. The use of gums has been the subject of extensive research in the food industry (Kaur & Gupta, 2002; Miyamoto et al., 2005; Stankov et al., 2018). Industrial production of different types of cakes plays an important functional role in the novel food products.

Today, the demand for more varied and safe food products such as cake with a better appearance and quality is increasing, so food artisans should look for ways to produce longer shelf life of food products (Maleki & Milani, 2013). Also, one of the reasons for the increased firmness and reduced marketability of such products during shelf life is the increased loss of moisture during storage (Nagipour et al., 2015; Ayoubi et al., 2008). So one of the most common ways for improvement of cake performance is the use of hydrocolloids, especially gums. Gums can affect moisture control, taste, physical properties, porous texture, and overall quality of the product (Maleki & Milani, 2013). Some of these effects have been reported by previous researchers (Maleki & Milani, 2013; Sharadanant & Khan, 2003; Bárcenas et al., 2009; Polaki et al., 2010, Stankov et al., 2018).

Turabi et al. (2010) examined the interior of a rice cake in the presence of several types of gums and found that the addition of xanthan and the combination of xanthan and guar had a significant effect on pore sizes of cake. Ayubi et al. (2008) investigated the effect of proteins, guar and xanthan gums on quality and chemical properties of oily cake. The results showed that these compounds retained most of their physicochemical properties with protect the sensorial properties of the cake during shelf life. The developing effect of substituting guar or xanthan gums instead of fat in low-fat cakes was investigated. It was reported cakes containing xanthan gum were better with respect to all properties in the experiments (Zambrano et al., 2004). Therefore, the aim of this study was to investigate the improvement of physicochemical, sensorial, textural properties and shelf life of cocoa sponge cake formulated with xanthan hydrocolloid in four concentrations.

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https://doi.org/10.22059/jfabe.2021.319703.1087

Table 1. The formulation of sponge cake

Ingredients	Wheat flour (g): protein (9.15 %), Ash (0.41 %) and Moisture (13.24 %)	Liquid edible oil (g)	Sugar (g)	Baking powder (g)	Milk (g)	Water (g)	Egg (g)
Content	100	33	72	5	30	10	63

Table 2. Moisture content (%), ash content (%) and protein content (%) of cocoa sponge cake containing xanthan gum.

Treatment \ Days	1	15	30
		Moisture content (%)	
Control	15.6 ± 0.02^{b}	11.6± 0.02^{c}	8.6± 0.02^{e}
T1	16± 0.02^{a}	15.6± 0.03^{b}	9.8± 0.05^{d}
T2	16.3± 0.06^{a}	15.8± 0.02^{b}	10.4± 0.02^{d}
T3	16.5 ± 0.02^{a}	15.9± 0.01^{b}	10.6 ± 0.03^{d}
		Ash content (%)	
Control	0.54± 0.02^{b}	0.54 ± 0.01^{b}	0.54± 0.02^{b}
T1	0.61± 0.01^{a}	0.62± 0.02^{a}	0.63± 0.04^{a}
T2	0.62± 0.02^{a}	0.64 ± 0.05^{a}	0.65± 0.02^{a}
T3	0.63± 0.07^{a}	0.65± 0.02^{a}	0.66± 0.03^{a}
		Protein content (%)	
Control	9.11± 0.02^{b}	9.08± 0.02^{b}	9.06± 0.07^{b}
T1	9.62± 0.01^{a}	9.51± 0.02^{a}	9.48± 0.02^{a}
T2	9.78± 0.02^{a}	9.73± 0.03^{a}	9.69± 0.04^{a}
T3	9.97 ± 0.04^{a}	9.94± 0.02^{a}	9.91± 0.02^{a}

Different letters show the statistical significant differences ($p < 0.05$) for each test. The treatments: control, treatment containing 0.1% xanthan (T1), treatment containing 0.2% xanthan (T2) and treatment containing 0.3% xanthan (T3).

2. Material and Methods

2.1. Materials

Wheat flour was purchased from Golha Factory (Tehran, Iran). The ingredients used in preparation of sponge cake were shown in Table 1. Xanthan gum (E415) was purchased from Fufeng Company (China). Cocoa powder, which required 10% of the cake formulation, was used in accordance with the guidelines in Iranian National Standard No. 2553: 2006.

2.2. Cake production

To make the cake, firstly eggs were beaten for 6 min in a planetary cake mixer (model K5SS; Kitchen Aid) at 128 rpm. Secondly, edible oil, milk and sugar were added. Then flour, baking powder, cocoa powder and xanthan gum were added to the other ingredients. Ingredients were homogenized for 3 min and finally water was added. Subsequently, pour a 55 g of paste into the molds using a funnel. The baking process was then carried out in a hot air oven at 180 °C for 30 min. After cooling, each sample was packed in polyethylene bags for evaluation of quantitative and qualitative properties and stored at ambient temperature (Dadvar et al., 2018).

2.3. Physicochemical tests

Moisture, ash, protein, volume and texture experiments were evaluated. A period of 30 days was considered as the storage time (at 1, 15 and 30 days). Xanthan gum was also used at 0, 0.1, 0.2 and 0.3% levels. Thus, the treatments are including: the treatment without xanthan as control, treatment containing 0.1% xanthan (T1), treatment containing 0.2% xanthan (T2) and treatment containing 0.3% xanthan (T3).

2.3.1. Ash measurement

Ash measurements were performed according to the Iranian National Standard No. 2553 (the characteristics and methods of cake testing).

2.3.2. Moisture content

The moisture content was checked in according to AACC Standard No. 16-44: 2000. In this test, the samples were placed in an oven at a temperature of 100-105 °C for three consecutive days (Yanpi et al., 2017).

2.3.3. Protein content

The protein measurement was carried out in accordance with the International Association for Cereal Chemistry (ICC)-ICC Standard No, 105/2: 1994.

2.3.4. Cake volume value

Cake volume evaluation was carried out using the method of rapeseed movement, in accordance with AACC StandardNo. 72-10: 2000 (Dadvar et al., 2018; Yanpi et al., 2017).

Table 3. The effect of xanthan gum on the volume value (ml/g), hardness (N) and cohesiveness of cocoa sponge cake.

Treatment \ Days	1	15	30
	Volume value (ml/g)		
Control	110± 0.2^{d}	105± 0.2^{f}	94± 0.2^{h}
T1	112± 0.2^{cd}	108± 0.3^{de}	103± 0.2^{g}
T2	126± 0.2^{a}	119± 0.2^{b}	116± 0.2^{c}
T3	120± 0.2^{b}	114± 0.2^{c}	111± 0.2^{d}
	Hardness (N) of cake		
Control	13.013± 0.2^{k}	32.205± 0.1^{f}	54.345± 0.2^{c}
T1	16.676± 0.4^{j}	37.613± 0.2^{e}	57.657± 0.1^{a}
T2	11.631± 0.2^{m}	25.306± 0.3^{h}	38.456± 0.3^{d}
T3	12.92± 0.2^{l}	30.599± 0.2^{g}	55.467± 0.2^{b}
	Cohesiveness of cake		
Control	0.68± 0.4^{a}	0.49± 0.1^{c}	0.32± 0.2^{d}
T1	0.52± 0.2^{b}	0.38± 0.2^{d}	0.25± 0.4^{e}
T2	0.47± 0.1^{c}	0.32± 0.3^{d}	0.18± 0.2^{f}
T3	0.48± 0.2^{c}	0.42± 0.2^{c}	0.19± 0.1^{f}

Different letters show the statistical significant differences ($p < 0.05$) for each test. The treatments: control, treatment containing 0.1% xanthan (T1), treatment containing 0.2% xanthan (T2) and treatment containing 0.3% xanthan (T3).

Table 4. The effect of xanthan gum on the springiness (mm), gumminess (N) and chewiness (N) of cocoa sponge cake.

Treatment \ Days	1	15	30
	Springiness (mm) of cake		
Control	0.83± 0.2^{a}	0.79± 0.2^{b}	0.75± 0.2^{b}
T1	0.82± 0.2^{a}	0.72± 0.3^{b}	0.70± 0.5^{b}
T2	0.69± 0.1^{c}	0.61± 0.2^{c}	0.58± 0.2^{d}
T3	0.73± 0.2^{b}	0.71± 0.1^{b}	0.68± 0.1^{c}
	Gumminess (N) of cake		
Control	8.789± 0.2^{g}	15.869± 0.2^{d}	23.767± 0.2^{a}
T1	8.617± 0.2^{g}	14.277± 0.1^{e}	21.647± 0.2 ^{b}
T2	5.494± 0.1^{k}	7.985± 0.2^{h}	10.768± 0.3^{f}
T3	6.248± 0.4^{j}	16.234± 0.1^{c}	23.576± 0.2^{a}
	Chewiness (N) of cake		
Control	7.295± 0.1^{g}	12.536± 0.1^{d}	17.577± 0.1^{a}
T1	7.066± 0.1^{g}	10.280± 0.2^{f}	13.686± 0.3^{c}
T2	3.791± 0.2^{a}	4.871± 0.1^{j}	6.435± 0.1^{h}
T3	4.561± 0.1^{j}	11.500± 0.4^{e}	15.456± 0.5^{b}

Different letters show the statistical significant differences ($p < 0.05$) for each test. The treatments: control, treatment containing 0.1% xanthan (T1), treatment containing 0.2% xanthan (T2) and treatment containing 0.3% xanthan (T3).

Table 5. Sensory evaluation of cocoa sponge cakes.

Adjective \ Sample	Control	T1	T2	T3
Texture	2.08± 0.02^{a}	1.85± 0.01^{b}	2.40± 0.05^{a}	2.25± 0.02^{a}
Color	2.05± 0.02^{a}	2.31± 0.06^{a}	2.40± 0.02^{a}	2.18± 0.07^{a}
Aroma	1.90± 0.02^{b}	2.15± 0.05^{a}	2.40± 0.02^{a}	2.32± 0.03^{a}
Taste	2.23± 0.02^{a}	2.11± 0.04^{a}	2.37± 0.03^{a}	2.37± 0.02^{a}
Total Acceptance	1.90± 0.02^{b}	2.40± 0.01^{a}	2.40± 0.02^{a}	2.24± 0.01^{a}

Different letters in every column show the statistical significant differences ($p < 0.05$). The treatments: control, treatment containing 0.1% xanthan (T1), treatment containing 0.2% xanthan (T2) and treatment containing 0.3% xanthan (T3).

2.3.5. The texture specifications of the cake

Texture profile analysis tests correlated well with sensory evaluation data. Cake texture was assessed on days 1, 15 and 30 using the Brookfield texture meter device (CT3 model) and TPA test. In this test, a piece (30×30×30 mm) of cake was cut with a knife and placed under the probe of the device. A flat cylindrical probe with a 40 mm as outer diameter was selected to compress each sample up to 25% of its initial height, a starting point of 0.5 N (Dadvar et al., 2018; Amirabadi et al., 2007).

2.4. Sensory evaluation

Five-point hedonic method was used to evaluate the sensory properties of the cake. For this purpose, 8 evaluators were selected and each one was given a coded sample with a scoring form and texture, color, aroma, and taste properties and overall acceptability were evaluated (Yanpi et al., 2017; Farahani et al., 2013).

2.5. Statistical analysis

All the results reported are an average of three replicates and were expressed as mean ± standard deviation of the triplicates and used one-way and two-way analysis of variance (ANOVA). Duncan's multiple-range test was also used to separate significant differences between means at the significance level ($p < 0.05$) in the SPSS 26 software (SPSS Inc., Chicago, USA).

3. Results and Discussion

3.1. Moisture, Ash and Protein

The results of moisture, ash and protein measurements in Table 2 showed that all treatments were significantly different from the control. As xanthan concentrations increased, there was an upward trend in the amount of moisture, ash, and protein, but there was no significant difference at the 0.05 level.

The reason for the increase in moisture is the high water absorbance capacity of the gum structure. According to National Iranian Standard No. 2553 (1999), moisture content is also in the range of 16-22%, which results were consistent. The moisture of treatments decreased during shelf life, but the treatments containing gum had higher moisture content than the control. Gomez et al. (2008) showed that the use of different gums increased the moisture content of the produced yellow cakes. Increased ash content is due to the high mineral and fiber content in the gum structure. Also, Turabi et al. (2010) also showed an increase in ash content of gum products compared to control. According to Iranian National Standard No. 2553 (1999), the minimum protein is eight percent and the present study is in accordance with it. Miller (1983) have shown that the addition of xanthan gum in cakes which depicted a slight increase in protein, due to the presence of some amino acids in the structural composition of the used gums. Also, Abbaszadeh et al. (2017) revealed the addition of xanthan significantly increased the protein content of the samples compared to the control sample.

3.2. Cake volume value

The results of the cake volume measurement (Table 3) showed that the increasing of xanthan concentration in formulation demonstrated a significant increase ($p < 0.05$) in the cake volume (except in T3). During storage, a decrease in volume was observed in all treatments, but the treatments containing xanthan were more voluminous than the control. Cake volume indicates the air and vapor content generated through baking cake and a significant increase was observed with increasing xanthan gum content to a certain extent (0.2%). The T2 had the highest cake volume due to its low dough density. Low dough density indicates more air bubbles in the dough and high viscosity of the dough keeps the bubbles in the dough longer and increases the cake volume. The volume of cakes also decreased during storage. The decrease in specific volume over time is most affected by the loss of moisture. Gomez et al. (2007) investigated the effect of different hydrocolloids on cake volume and showed that xanthan-prepared cake had a high specific volume. Arozarena et al. (2001), Sciarini et al. (2012) and Demirkesen et al. (2010) examined the effect of gums on the volume of gluten-free paste products and found that the use of gums were effective in increasing the volume.

3.3. Texture Profile Analysis (TPA)

Hardness indicates the foodstuff resistance to compressing force. The results of Table 3 show that the effect of xanthan gum on cake's hardness is significant at 0.05 level at different days. The gums have a hydrophilic structure and are able to absorb water, which reduces the force required to rupture the cake texture and increasing shelf life. As the gum content increased, the cake's hardness also increased, but after the T2, a decreasing trend was observed and the hardness of all treatments increased over time.

Cohesiveness represents the intrinsic resistance of the food structure (Table 3) and its extent depends on the intermolecular interactions of the formulation components. The effect of xanthan gum on the cohesiveness of the cake was significant compared to the control. As the amount of xanthan gum increases, the cohesiveness of the cake decreases except T3. Over time, the cohesiveness of all samples decreased.

The springiness of the samples (Table 4) reflects the amount of degraded foodstuff return to the initial state after removal of the force, also called the elastic state. The effect of xanthan gum on the springiness of the cake was significant. As the xanthan gum increases, the springiness of the cake decreases except T3. Over time, a decreasing trend was observed in all treatments.

Gum properties like chewing ability indicates required energy for oral digestion and preparation for swallowing. The gumminess state of the cake decreases with increasing xanthan gum until 0.2% gum. A decreasing trend over time was also observed in all treatments (Table 4).

Chewiness factor represents (Table 4) the required energy to chew solid food to obtain a ready-to-swallow product that results from multiplying the hardness factor in the sample's cohesiveness and springiness. Increasing the amount of xanthan reduces the chewing ability of the treatments (except T3). An increasing trend in chewiness was observed in all treatments over time.

The hardness of the cake increases with increasing gum content. Gums increase the viscosity of the liquid phase of the dough to enhance the strength of the gaseous cell wall in the product. Because of this, the cake's resistance to pressure is increased by the probe of the device, which is consistent with the findings of Arozarena et al. (2001). The addition of hydrocolloids facilitates the absorption of water and increases the viscosity of the dough and increases the density of the treatments and reduces the springiness (Gomez et al., 2007). Therefore, increasing xanthan gum at high levels results in increased texture compaction, hardness and chewiness, and in decreased cohesiveness and springiness of product (Keshavarzipour et al., 2018). In this regard, Gomez et al. (2007) also observed that xanthan gum produced more cohesiveness to yellow layer cake than alginate, carrageenan, locust and guar gum. It was also reported that the process of changing the data on the resin cake had no negative effect on it.

3.4. Sensory evaluation

Sensory evaluation was performed using 5-point hedonic test. It can be seen at Table 5, the xanthan treatments did not differ significantly ($p < 0.05$) in terms of color, texture and taste characteristics, but showed a significant difference compared to the control ($p < 0.05$) about aroma. The T2 had the highest score in terms of texture, color and aroma, which could be attributed to the fact that the hydrocolloids had the highest moisture content and water retention capacity. Their structure creates more desirable texture and sensory properties. Also, the presence of some amino acids in the structural composition of the gums and heated during baking can cause a pleasant aroma. The T1 and T2 had the highest score in terms of total acceptance and the lowest score belonged to the control.

4. Conclusion

Today, consumers are looking for high quality and healthy products that are associated with the production of valuable products. Therefore, it is essential to utilize consumer-friendly products to maintain and expand the market for food industry and food processing. According to the results, xanthan gum (0.2%) can be used in order to enhance the quality and shelf life of the cake. Xanthan gum cake had better soft cake during storage than the control and had better sensorial properties than the control. This gum can be used to make sponge cakes and reduce the use of preservatives.

Acknowledgment

The author would like to thank Science and Research Branch of Islamic Azad University for providing support to carry out this study.

Conflict of interest

The authors declare that they have no known competing financial interests.

References

Abbaszadeh, F., Alami, M., Sadeghi Mahoonak, A., Kashaninejad, M. (2017). Influence of sweet almond protein concentrate and xanthan gum on physic-chemical and textural properties of dough and rice cakes. *Innovative Food Technologies*, *4*(3), 107-118..

Amirabadi, S ., Small, A ., & Mohebbi, M. (2007). Investigating the effect of xanthan gums and urban step on the quality and durability of chiffon cake. *Iranian Journal of Food Science and Industry Research*, *10*(4), 375-386.

Arozarena, I., Bertholo, H., Empis, J., Bunger, A., & Sousa, I. (2001). Study of the total replacement of egg by white lupine protein, emulsifiers and xanthan gum in yellow cakes. *European Food Research and Technology*, *213*(4), 312-316.

Ayoubi, A., Habibi Najafi, M. B., & Karimi, M. (2008). The effect of adding whey protein concentrate and guar and xanthan gums on the qualitative and physicochemical properties of oil cake. *Iranian Journal of Food Science and Industry Research*. 33-46.

Bárcenas, M. E., De la O-Keller, J., & Rosell, C. M. (2009). Influence of different hydrocolloids on major wheat dough components (gluten and starch). *Journal of Food Engineering*, *94*(3-4), 241-247.

Dadvar, P ., Ata Salehi, A ., & Shaykh al-Islami, Z. (2018) Gluten-free cake formulation and evaluation of its qualitative properties. *Journal of Innovation in Food Science and Technology*, *10*(2), 70-57.

Demirkesen, I., Mert, B., Sumnu, G., & Sahin, S. (2010). Rheological properties of gluten-free bread formulations. *Journal of food Engineering*, *96*(2), 295-303.

Farahani, Z. K., Farahani, F. K., Yousefi, M., & Nateghi, L. (2013). Comparison of different commercial cheese characteristics in Iran. *European Journal of Experimental Biology*, *3*(3), 257-260.

Gómez, M., Ronda, F., Caballero, P. A., Blanco, C. A., & Rosell, C. M. (2007). Functionality of different hydrocolloids on the quality and shelf-life of yellow layer cakes. *Food hydrocolloids*, *21*(2), 167-173.

Iranian Institute of Standards and Industrial Research, National Standard of Iran. (2006). Features and methods of cake testing. No. 2553.

International Association for Cereal Chemistry (ICC)-ICC Standard, (1994). Determination of Crude Protein in Cereals and Cereal Products for Food and for Feed. No. 105/2.

Kaur, N., & Gupta, A. K. (2002). Applications of inulin and oligofructose in health and nutrition. *Journal of biosciences*, *27*(7), 703-714.

Keshavarzipour, A., Abbasi, L., & Fazel, N. (2018). The effect of guar gum and xanthan gum and sodium stearyl lactate emulsifier on quality characteristics of gluten-free sponge cake based on corn and acara starch. *Food Science and Nutrition*, *15*, 87-100.

khoshdouni farahani, Z., khoshdouni farahani, F. (2017). Chemical identification of clove (*Syzygium aromaticum*) extract and essential oil. *Applied Biology*, 7(27), 1-7.

Maleki, G., & Milani, J. M. (2013). Effect of guar gum, xanthan gum, CMC and HPMC on dough rhealogy and physical properties of Barbari bread. *Food Science and Technology Research*, *19*(3), 353-358.

Miller, L. L. (1983). Xanthan gum in a reduce egg white angel food cake. *Cereal Chemistry*, *60*, 62-65 .

Miyamoto, Y., Sakamoto, M., Maeda, T., & Morita, N. (2005). Application of polyglycerol mono-fatty acid esters to improve bread making. *Food science and technology research*, *11*(1), 19-25.

Naghipour, F., Sahraeian, B., Habibi Najafi, M. B., & Haddad Khodaparast, M. H. (2015). Investigation of the effect of asparagus gum on the shelf life and quality of hybrid oil cake (wheat-sorghum). *Journal of Technology in Science and Technology*, *7*(3), 1-9.

Polaki, A., Xasapis, P., Fasseas, C., Yanniotis, S., & Mandala, I. (2010). Fiber and hydrocolloid content affect the microstructural and sensory characteristics of fresh and frozen stored bread. *Journal of Food Engineering*, *97*(1), 1-7.

Sciarini, L. S., Ribotta, P. D., Leon, A. E., & Perez, G. T. (2012). Incorporation of several additives into gluten free breads: Effect on dough properties and bread quality. *Journal of Food Engineering*, *111*(4), 590-597.

Sharadanant, R., & Khan, K. (2003). Effect of hydrophilic gums on the quality of frozen dough: II. Bread characteristics. *Cereal Chemistry*, *80*(6), 773-780.

Stankov, S. S., Baeva, M. R., & Petkova, N. T. (2018). Physical and sensory characteristics of sponge cakes containing an additive of modified fructooligosaccharides. *International Food Research Journal*, *25*(5), 2099-2103.

Turabi, E., Sumnu, G., & Sahin, S. (2010). Quantitative analysis of macro and micro-structure of gluten-free rice cakes containing different types of gums baked in different ovens. *Food hydrocolloids*, *24*(8), 755-762.

Yanpi, M., Alami, A., Mohammadzadeh, J., Sadeghi, A.R, & Kashiri, M. (2017) . The effect of adding white corn flour and xanthan gum on the physical and sensory properties of gluten-free cake based on rice flour. *Food Science and Technology*, *73*(14), 319-330.

Zambrano F, Zambrano, F., Despinoy, P., Ormenese, R. C. S. C., & Faria, E. V. (2004). The use of guar and xanthan gums in the production of 'light'low fat cakes. *International journal of food science & technology*, *39*(9), 959-966.