Effect of Adding Different Gums and Emulsifiers on Quality Attributes and Staling Rate of Microwave-Baked Cakes

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ABSTRACT

The effects of various gums and emulsifiers on baking quality, sensory characteristics and staling retardation of microwave-baked cakes were investigated. The gums used were xanthan, Arabic gum and carrageenan each at levels of 0.5, 0.75 and 1.0%, and emulsifiers used were angato gel, energy 100 and spongolit 283 at 3% in cake batter formulations. No gums or emulsifiers were added in the control cake baked in microwave oven. The results demonstrated that the volume and the specific volume of cakes were significantly ($P \leq 0.05$) increased when gums and spongolit 283 at level of 0.75% and 3%, respectively were added as compared to the control. Addition of xanthan at 1.0% in the cakes gave the highest moisture content followed by carrageenan and finally Arabic gum as compared to the control cake. Also angato gel and spongolit 283 were effective in retaining the moisture during storage. A significant ($P \leq 0.05$) lower staling rate resulted in the cakes containing xanthan at all levels and spongolit 283 followed by angato gel and energy 100 in comparison to the control sample. High acceptable cakes were obtained by adding xanthan or carrageenan or Arabic gum at level 0.75%. The addition of spongolit 283 to the cakes, significantly ($P \leq 0.05$) improved the sensory characteristics followed by angato gel and energy 100 as compared to the control. In conclusion, our results suggested that high quality microwave-baked cakes, more acceptable sensory properties, high moisture content, low weight loss and extended shelf life can be obtained by adding gums and emulsifiers.

Keywords: ***Microwave, cake, gums, emulsifiers, moisture loss, sensory evaluation, staling.***

INTRODUCTION

Heating with microwave energy is distinctly different from conventional heating. Whereas conventional heating depends upon the slow transfer of heat by conduction from the surface to the interior, and is controlled by the differential in temperature from the hot surface to the cool interior, heating with microwave energy is bulk heating in which the microwave field interacts with the material as a whole (Schiffmann, 1992).

Microwave heating offers a new way of baking and brings a lot of advantages such as less start-up time, faster heating, saving of energy (up to 60% versus gas conventional ovens), space savings, selective heating, and high nutritional quality (Reiger & Schubert, 2001, Sumnu & Sahin, 2005). An important advantage of microwave baking is that microwave-baked goods are rich in nutrients than conventionally baked goods because the essential amino acids, are still available after microwave baking (Tsen, 1980). On the other hand, microwave-baked products have some quality problems, like reduced height of product, low volume, tough or firm texture, dense or gummy texture, lack of browning and flavour development and undesirable moisture gradient along vertical axis in final baked product. The using of microwave oven in baking cakes resulted in acceleration of staling as well as higher moisture loss comparing with conventional baking methods (Sumnu, 2001). One of the reasons for these problems is that physicochemical changes and interactions of major ingredients, which would normally occur over a lengthy baking period in a conventional system, cannot always be completed during the short baking period of a microwave system (Hegenbert 1992). Other reasons are specific interactions of each component in the formulation with microwave energy (Goebel *et al*., 1984).

Staling is a generic term used to describe loss of freshness perceived by consumers. It includes crumb firming, development of crumb dryness, loss of flavour and similar changes (Kulp *et al*., 1991). Moisture content is an important parameter for staling. Some studies showed that elevating the moisture content of product by 2% increased its shelf life by one day (Stauffer, 2000). Therefore, high moisture loss in microwave-baked goods was thought as a reason for rapid staling in microwave baking.

When food materials heated in a microwave oven, relatively larger amounts of interior heating result in increased moisture vapour generation inside of a solid food material, which creates significant interior pressure and concentration gradients. Positive pressures generated inside of a food material increase the flow of the vapour and liquid through the food material to the boundary. Adding hydrocolloids can be used to increase moisture retention as well as emulsifiers as found by Stauffer (2000) and Seyhun *et al*. (2003).

Gums are water-soluble polysaccharides with high molecular weights (up to one million dalton). They act as texture improvers, emulsifiers, fat reducers, binding agents, film formers, stabilizers, shelf-life extenders (Gurkin, 2002). Gums are added to the food products mainly for their thickening and gelling properties. In addition, they are used to improve mouth feel and to change the viscosity of solutions due to their high polymeric nature and the interactions between polymer chains when they are dissolved or dispersed (Yaseen *et al*., 2005). Gums are often added in cake formulas to increase the viscosity and stability of the batter, prevent staling, improve the texture of the cake, and increase moisture retention (Seyhun *et al*., 2003). Addition of xanthan and xanthan-guar gum blend increased total number of pores of the microwave baked rice cakes (Turabi *et al*., 2010).

Emulsifiers that have a common use in the baking industry have the ability to provide the necessary aeration and gas bubble stability during the process until the cake structure is set (Sahi & Alava, 2003). Emulsifiers function reduces the interfacial tension between oil and water and therefore, facilitates the disruption of emulsion droplets.

Using different emulsifier and gum types helped to retard staling of microwave-baked cakes effectively. Cakes formulated with Purawave or DATEM had the highest moisture retention and were the softest. Using gums with emulsifiers gave better moisture retention and softer cakes than using gums alone (Seyhun *et al*., 2003).

The objective of the present study is to evaluate the effect of adding different gums and emulsifiers on some quality attributes and retarding staling rate of microwave-baked cakes.

MATERIALS AND METHODS

Materials

Commercial wheat flour (72% extraction), whole fresh egg, sucrose, shortening, milk powder, cocoa powder, baking powder and salt (sodium chloride) were purchased from local market, Cairo, Egypt. Xanthan (bacterial source), Arabic gum (plant source) and carrageenan (seaweed source) were obtained from Sigma Chemical Co. (St. Louis, Mo.), USA. Spongolit 283 powder containing 35% emulsifiers (mono and diglycerides esterified with lactic acid and polyglycerol ester), and 65 % carrier (glucose syrup solids, skim milk powder and stabilizer) was obtained from Cognis Deutschland GmbH & Co. KG, Standort, Germany; angato gel (containing monoglyceride E 471, propylenglycol monostearate, polyglycerol esters E 472, and water) and energy 100 (which contains wheat flour, ascorbic acid, α-amylase, diacetyl tartaric ester and sugar ester) were provided from Golden Bake Co., Cairo, Egypt.

Preparation of cakes

Cakes were prepared according to the method of Seyhun *et al*., (2005). Cake batter contained 100g of wheat flour, 100g of sugar, 50g of shortening, 125g of water, 12g of milk powder, 9g of whole egg liquid, 10g of cocoa powder, 3g of salt and 5g of baking powder. Egg and sugar were mixed in a mixer at its lowest speed, for one minute. Fat was added and mixed. All the dry ingredients and water were added simultaneously and mixed for two minutes until the cake batter was obtained. Two experimental treatments were carried out in this investigation to produce microwave cakes. The first one was the addition of xanthan, Arabic gum and carrageenan each at levels 0.5, 0.75 and 1.0%, to the batter. The second treatment was adding spongolit 283, angato gel and energy 100 each at 3% (which recommended by manufacture) to the cake batter. Forty grams of cake batter were weighed in a greased glass baking pan (12.5 cm in diameter). The baking pan was placed in the center of the microwave oven (Sharp, type R-2J28 with cavity dimension 285 mm (W) × 178 mm (H) × 316 mm (D)) and baked at 100% power (700 W) for 70 sec. The control cakes formulation without addition gums or emulsifiers were baked in the microwave oven. After baking, the cakes were cooled to room temperature (23±2°C) for one hour. Then, the cakes were wrapped with stretch film, and stored at room temperature (23±2°C) for six days.

Specific gravity of the batter and measurements of cakes

Specific gravity of the cake batter was calculated according to the method of Jyotsna *et al*., (2004); weight (g), volume (cm^3) and specific volume (cm^3/g) of different cake samples were measured according to the method of Bennion & Bamford (1997). Weight loss (%) of the different prepared cake samples was determined after baking and cooling and after 2, 4 and 6 days of storage period according to the method of Sakiyan *et al*., (2007)

Moisture content of cakes

Moisture content of the prepared cake samples was determined according to the method described in the AOAC (2000), method number 44-15A.

Determination of cake staling

The staling rate of the different prepared cake samples was determined after baking within one hour and after 2, 4 and 6 days of storage at room temperature (23±2 oC) by alkaline water retention capacity (AWRC %) according to the AACC 56-10 method (AACC, 2000).

Sensory evaluation of cakes

Cake samples were assessed for their quality attributes after baking by ten members preference taste panels from the staff of the Food Science Dept. Fac. of Agric., Ain Shams Univ. They were asked to score the internal characteristics of cake samples i.e. cell uniformity, grain, texture, crumb colour and flavour using the respect sheet according to the AACC (2000).

Statistical analysis

Data were expressed as the means ± SD. Statistical analysis was carried out using the PROC ANOVA followed by Duncan's Multiple Range Test with $P \leq 0.05$ being considered statistically significant to compare among means according to Snedecor & Cochran (1980). All procedures were carried out in triplicate and statistically analyzed using Statistical Analysis System Program (SAS, 1996).

RESULTS AND DISCUSSION

Specific gravities of the cake batters and some measurements of cakes containing gums

The specific gravities of the cake batters and some measurements of the produced cakes are presented in Table (1). The amount of air incorporated into the batter was determined by measuring the specific gravity of the batter. The addition of different gums at different levels caused a noticeable increase in the specific gravity of the batters. The cakes containing 1.0% xanthan provided the highest significant ($P \leq 0.05$) batter specific gravity followed by cake contained Arabic gum (0.75%) then carrageenan (1.0%). On the other trend, the batter containing carrageenan at levels 0.5 % and 0.75% had the lowest specific gravity.

Table 1: Specific gravities of cake batters and some measurements of the cakes containing different levels of gums

Gums (%)		Batter specific gravity	Cakes		
			Weight (g)	Volume (cm^3)	Specific volume (cm^3/g)
Control		1.031 ± 0.005^{ef}	35.81 ± 0.30^{bc}	62 ± 2.00^{g}	1.73 ± 0.07^{h}
Xanthan	0.50	1.048 ± 0.005^{d}	36.53 ± 0.24^{a}	91 ± 1.15^{c}	2.50 ± 0.05^{d}
	0.75	1.040 ± 0.144^{de}	36.31 ± 0.11^{ab}	101 ± 2.65^{b}	2.78 ± 0.08^{c}
	1.00	1.136 ± 0.005^{a}	36.06 ± 0.34^{abc}	78 ± 3.05^{f}	2.18 ± 0.11^{fg}
Arabic gum	0.50	1.067 ± 0.003^{c}	35.74 ± 0.44^{bc}	75 ± 3.00^{f}	2.10 ± 0.07^{g}
	0.75	1.092 ± 0.003^{b}	35.86 ± 0.29^{bc}	117 ± 3.05^{a}	3.25 ± 0.06^{a}
	1.00	1.065 ± 0.006^{c}	36.01 ± 0.33^{abc}	85 ± 1.00^{de}	2.36 ± 0.04^{de}
Carrageenan	0.50	1.042 ± 0.004^{d}	35.79 ± 0.17^{bc}	95 ± 3.00^{c}	2.65 ± 0.10^{c}
	0.75	1.027 ± 0.010^{f}	35.79 ± 0.31^{bc}	105 ± 5.00^{b}	2.93 ± 0.12^{b}
	1.00	1.087 ± 0.008^{b}	35.59 ± 0.37^{c}	86 ± 2.00^{d}	2.42 ± 0.05^{de}

Data are the mean ± SD, n = 3, Mean values in the same column bearing the same superscript do not differ significantly ($P \leq 0.05$).

Generally, significant ($P \leq 0.05$) differences in both means of the volume and the specific volume among the cakes containing different ratios of gums and the control cake were noticed. The control cake recorded the lowest volume and specific volume; this was attributed to the insufficient starch gelatinization as mentioned by Yin & Walker (1995). The volume increased when the levels of gums increased from 0.5 to 0.75% but a reverse trend was appeared when the level increased to 1.0% in all types of gums. The results of the specific volume of the different cakes were depending on cake volume so; a similar trend was observed in this parameter. The specific volume is an indication of cake lightness; it means that the higher value of specific volume the lighter cake is. This positively affects both texture and tenderness (El-azab & Abd El-Lateef, 1997). The increasing in cake volume and specific volume was attributed to the help of particles of gums in the distribution of air cells during the preparation of batter. Also, gums have higher water retention capacity, so the cakes had greater ability to hold air cells inside (Prakongpan *et al*., 2002).

Moisture content of the cakes containing gums

The mean values of moisture content (%) of the different cake samples during storage were determined and the data are shown in Fig (1). The moisture content of the control sample was 23.43% at zero time of storage. The moisture loss in the microwaved product was attributed to the absence of a dehydrated crust which acts as a barrier to moisture transport during the baking process. A large amount of water was lost within a shorter period of time during microwave heating as mentioned by Umbach *et al*., (1990).

It was clearly appeared that the addition of gums enhanced the ability of the cakes to bind water during baking. As shown in Fig (1) when, the amount of added gums increased the moisture content significantly ($P \leq 0.05$) increased in all different microwave-baked cakes. The results showed that, there was a reduction in the moisture content in all the cake samples during storage (due to the water migration from the samples). The lowest values in the moisture content were appeared in the control cake samples which didn't have gums during subsequent storage. The cake samples which contained 1.0% xanthan had the highest significant ($P \leq 0.05$) moisture content at zero time and during subsequent storage period followed by the cakes contained carrageenan then Arabic gum at the same concentrations. It was observed that, the gums had significant ($P \leq 0.05$) effect on moisture content in the different cakes; this was due to their gelling properties and the higher binding water capacity as published by Yassen *et al*., (2005). Therefore, adding of gums to the batter cakes is beneficial, especially when cakes are baked in microwave oven.

Staling rate of the cakes containing gums

Cakes staling was measured and the obtained data are presented in Table (2). It could be noticed that, at zero time of storage there was significant ($P \leq 0.05$) effect of the different gums on retarding the staling rate of cakes. Meanwhile, the control cakes had the highest staling rate; this might be related to the high amount of amylose leached during microwave heating (Higo *et al*., 1983).

It was clear that, during storage at room temperature for 6 days, staling rates of the resultant control cake or cakes contained different levels of gums were found to be shorten by elongating the storage period. These results are in agreement with those of Shukla (1995). The cakes containing xanthan at levels of 0.5, 0.75 and 1.0 % had significantly ($P \leq 0.05$) lower staling rates in comparison to the other cake samples containing the Arabic gum and carrageenan at any time of storage. These results are going in parallel with those of moisture content. As a general, the cakes contained gums had lower staling rates than those without any gums. This was because of their higher water binding capacity and reducing the incidence of staleness as mentioned by Sumnu, (2001).

Weight loss of the cakes containing gums

Weight loss (%) was calculated using weight of the batter before baking and weight of the baked cake just after removing from the oven and cooling for one hour and every two days during storage at room temperature. The results of the weight loss of the different cake samples as affected by gum types at different concentrations after baking and during storage are shown in Fig (2). As can be seen, the control cake lost more moisture than the other cakes contained different concentrations of gums. On the other hand, the baked cakes containing different levels of different gums had the least weight loss as a result of high water binding capacity of gums as mentioned by Gurkin, (2002).

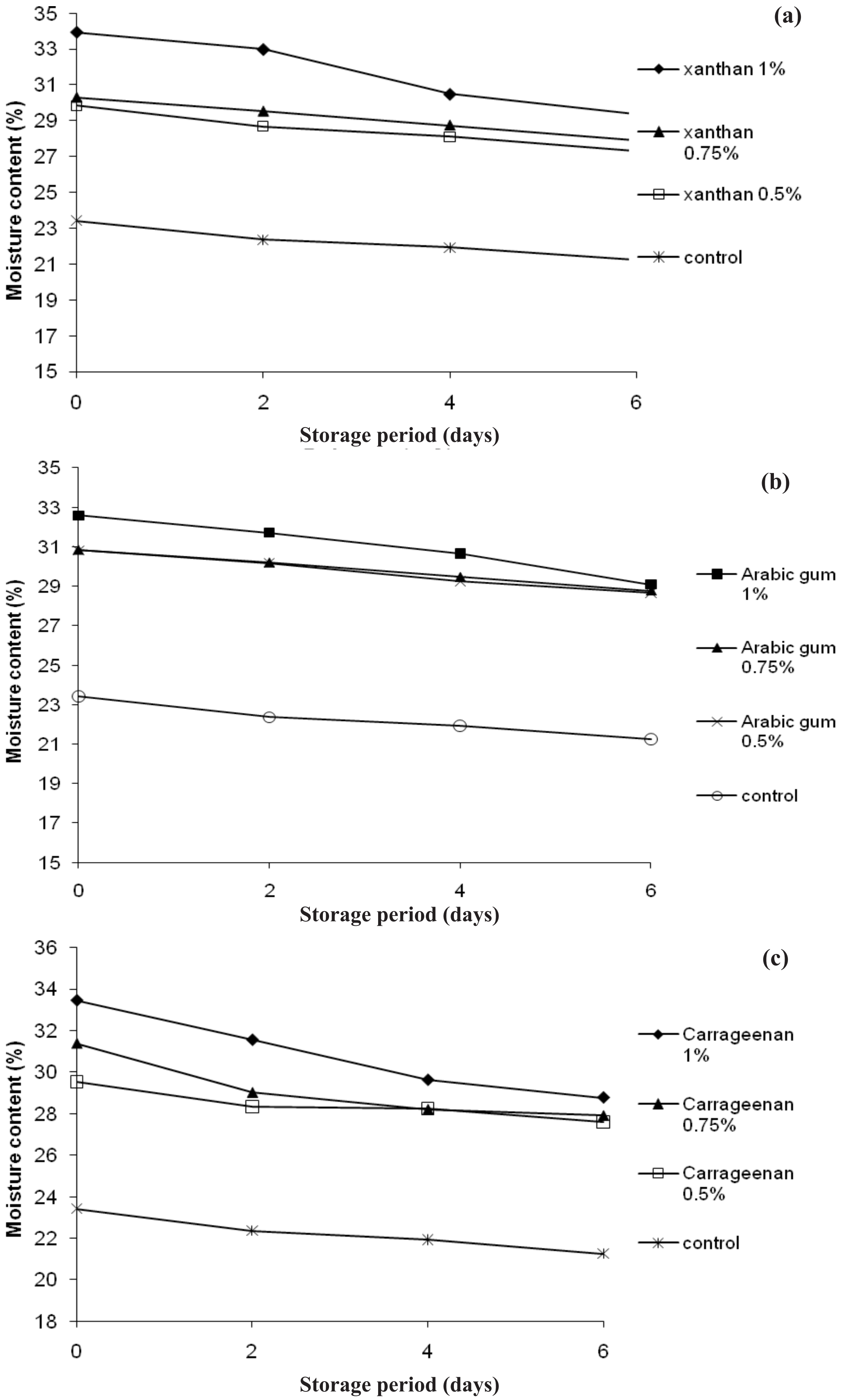

Fig. 1: Effect of different gums at different levels on moisture content of the cakes during storage. (a) Xanthan, (b) Arabic gum, (c) Carrageenan.

Table 2: Staling rate of cakes containing different levels of gums during storage.

Gums (%)		Storage period (days)			
		0	2	4	6
Control		225.2 ± 1.20^{Abc}	203.6 ± 0.00^{Bf}	190.5 ± 0.42^{Cg}	186.8 ± 4.70^{Dg}
Xanthan	0.50	225.5 ± 3.10^{Abc}	207.3 ± 0.14^{Be}	201.8 ± 1.00^{Cde}	198.0 ± 1.14^{Dc}
	0.75	227.7 ± 1.50^{Ab}	211.8 ± 1.20^{Bcd}	203.6 ± 0.57^{Cc}	199.6 ± 0.28^{Db}
	1.00	292.8 ± 1.00^{Aa}	266.3 ± 3.30^{Ba}	252.3 ± 2.50^{Ca}	228.3 ± 0.71^{Da}
Arabic gum	0.50	213.6 ± 1.40^{Ae}	200.8 ± 0.80^{Bg}	195.5 ± 2.90^{Cf}	188.6 ± 0.42^{Df}
	0.75	215.0 ± 1.70^{Ade}	204.1 ± 0.10^{Bf}	200.5 ± 0.42^{Ce}	189.2 ± 0.28^{Df}
	1.00	216.9 ± 3.30^{Ad}	205.5 ± 3.30^{Bef}	203.1 ± 0.70^{Ccd}	191.1 ± 0.38^{De}
Carrageenan	0.50	223.5 ± 0.70^{Ac}	205.8 ± 0.00^{Bef}	203.3 ± 3.25^{Ccd}	188.2 ± 0.57^{Df}
	0.75	224.7 ± 0.20^{Abc}	213.9 ± 0.70^{Bbc}	210.8 ± 0.00^{Cb}	194.1 ± 1.84^{Dd}
	1.00	226.3 ± 0.60^{Abc}	214.4 ± 1.20^{Bb}	212.5 ± 1.12^{Bb}	195.0 ± 2.26^{Cd}

Data are the mean ± SD, n = 3, Values followed by the same capital letters in the same row; and values followed by the same small letters in the same column are not significantly different (P≤0.05).

During storage, the weight loss of the different cakes increased. Control cakes had the highest values of weight loss till the end of storage period. Adding of any type of gums reduced the weight loss as compared to the control. In general, with increasing the percentage of the adding gums, the weight loss decreased at any time of storage at room temperature.

Sensory characteristics of the cakes containing gums:

The data in Table (3) represent the mean scores of cell uniformity, grain, texture, crumb colour, flavour and overall acceptability of the prepared cakes containing different concentrations of gums. The data show that, the cakes containing gums recorded higher crumb colour and overall acceptability than the control sample. These results are in agreement with the results of Sumnu (2001) who mentioned that, the cakes baked in microwave ovens at 100% power level had the same quality as cakes baked in conventional oven especially in texture and volume with optimum shortening content, water content, processing time and power. Power was found to be the most efficient variable affecting cake volume, tenderness and uniformity. The cakes containing xanthan, Arabic gum and carrageenan at 0.75% received the highest sensory scores than the other samples containing the other levels of these gums.

Generally, the cakes containing different levels of gums had better quality and showed significantly (P≤0.05) superior sensory properties scores than those of the control sample. This was attributed to the great water binding capacity, texture improvement and enhancement of crumb colour, eating quality and retarding of staling of cake samples.

Specific gravities of cake batters and some measurements of the cakes containing emulsifiers

The specific gravities of the cake batters and some measurements of different cakes containing different emulsifiers are shown in Table (4). It could be observed that there was no significant (P≤0.05) difference in batter specific gravity among the different samples; meanwhile, the cakes containing 3% of spongolit 283 recorded the lowest significant (P≤0.05) value. An inverse relationship between the batter specific gravity and the cake volume was observed. Meanwhile, the cake containing spongolit 283 (with the least specific gravity) recorded the highest volume. All the cakes containing different emulsifiers had higher volume than that of the control. Similar trend was appeared in the specific volume of the different cakes, the cakes containing spongolit 283 had the highest specific volume followed by those containing energy 100 and then angato gel cakes. The increase in the specific volume was attributed to the addition of emulsifiers which increase the amount of air entrapped in the cake structure because these surfactants affected the batter by mechanically favouring the fat liquid

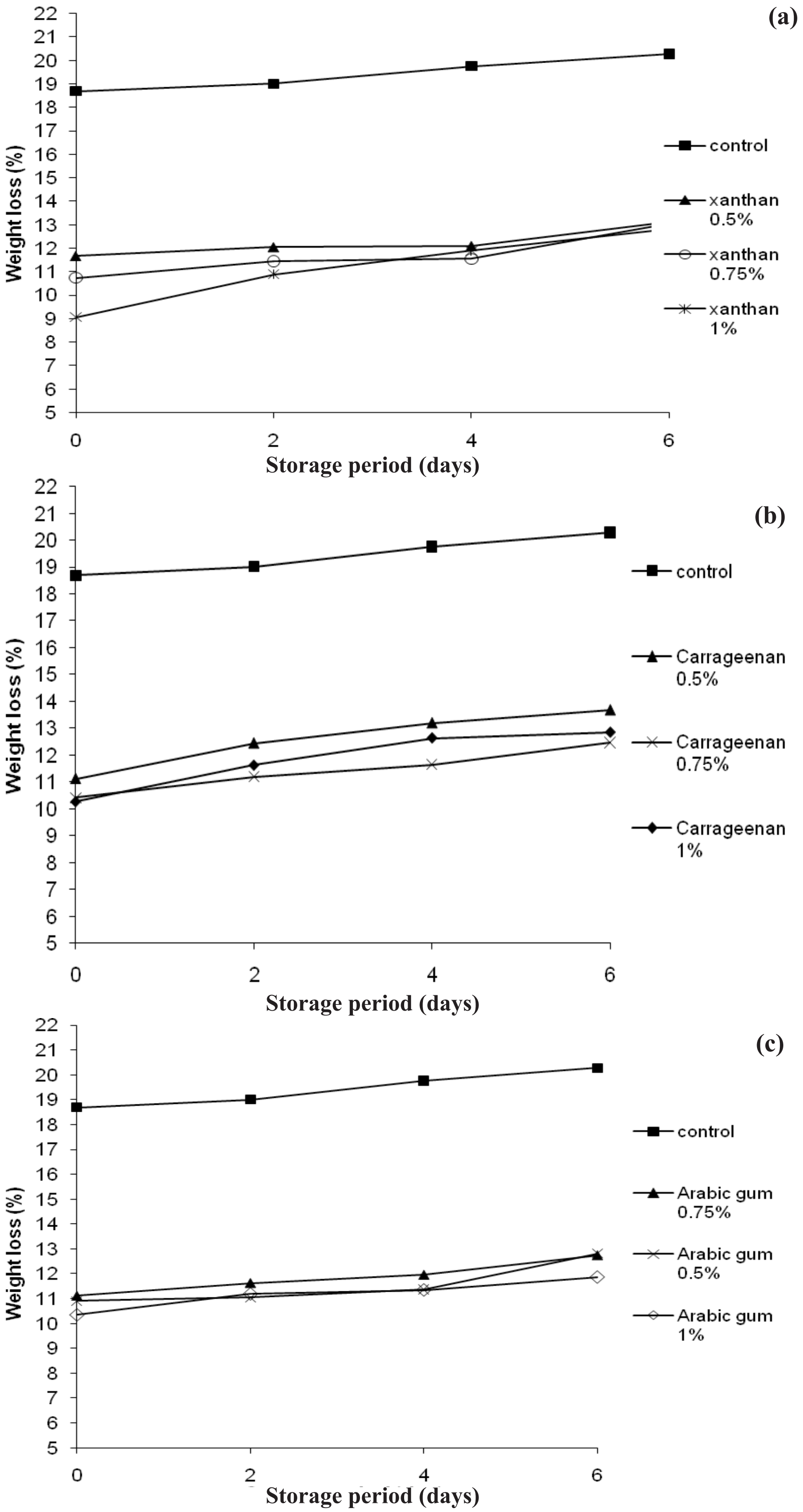

Fig. 2: Effect of different gums at different levels on weight loss of the cakes during storage. (a) Xanthan, (b) Arabic gum, (c) Carrageenan.

Table 3: Effect of different levels of gums on the sensory characteristics of cakes.

Gums (%)		Cell uniformity (30)	Grain (20)	Texture (30)	Crumb colour (10)	Flavour (10)	Overall acceptability (100)
Control		26.81^{bc}	17.29^{def}	26.23^{cde}	9.21^{a}	8.84^{bc}	88.29^{bcd}
Xanthan	0.50	26.46^{bc}	18.23^{bc}	25.47^{def}	8.45^{abc}	8.46^{c}	86.88^{cde}
	0.75	28.82^{a}	19.01^{ab}	28.00^{ab}	8.80^{abc}	9.68^{ab}	94.24^{a}
	1.00	20.27^{d}	17.64^{cde}	24.47^{f}	8.44^{abc}	8.69^{c}	79.28^{f}
Arabic gum	0.50	25.66^{c}	18.20^{bc}	24.23^{f}	7.81^{c}	8.83^{bc}	84.61^{e}
	0.75	27.29^{abc}	19.22^{a}	27.01^{abcd}	8.42^{abc}	9.64^{ab}	91.45^{ab}
	1.00	26.45^{bc}	16.87^{ef}	26.44^{bcde}	8.01^{bc}	8.61^{c}	86.22^{de}
Carrageenan	0.50	27.81^{ab}	17.82^{cd}	26.60^{bcd}	8.20^{abc}	9.68^{ab}	90.07^{bc}
	0.75	28.80^{a}	18.47^{abc}	28.61^{a}	9.09^{ab}	9.82^{a}	94.65^{a}
	1.00	27.63^{ab}	17.64^{cde}	27.60^{abc}	9.27^{a}	9.62^{ab}	91.63^{ab}

Data are the mean, n = 10, Mean values in the same column bearing the same superscript do not differ significantly ($P \leq 0.05$).

Table 4: Specific gravities of cake batters and some measurements of the cakes containing different emulsifiers.

Treatments	Batter specific gravity	Cakes		
		Weight (g)	Volume (cm^3)	Specific volume (cm^3/g)
Control	0.992 ± 0.005^{a}	35.98 ± 0.11^{d}	63 ± 2.12^{d}	1.75 ± 0.06^{d}
Angato gel (3%)	0.965 ± 0.003^{b}	35.11 ± 0.80^{bc}	67 ± 2.83^{c}	1.91 ± 0.04^{c}
Energy 100 (3%)	0.990 ± 0.003^{a}	34.45 ± 0.03^{cd}	74 ± 1.41^{b}	2.15 ± 0.04^{b}
Spongolit 283 (3%)	0.904 ± 0.005^{c}	36.41 ± 1.15^{a}	84 ± 2.12^{a}	2.31 ± 0.02^{a}

Data are the mean ± SD, n = 3, Mean values in the same column bearing the same superscript do not differ significantly ($P \leq 0.05$).

crystalline lamellae phase between the gas cells which in one hand, lowering its resistance to expanding gas resulted in more gas retention, and in the other hand, promoted the dispensability properties and stabilization of gas cells in batter. Protein–emulsifying activity is the ability of the protein to participate in emulsion formation and to stabilize the newly created emulsion (Ribotta *et al*., 2008).

Moisture content of the cakes containing emulsifiers:

The data of moisture content (%) of the different cakes during storage at room temperature are shown in Fig (3). It was clearly noticed that the control sample had the lowest moisture content than the other cakes. This was attributed to the effect of microwave treatment on the moisture loss of cakes as discussed before. Both cakes containing angato gel and spongolit 283 recorded the highest moisture content and were effective in retaining moisture during storage. The emulsifiers are used in baking industry for many reasons, including improved water absorption. The higher water binding capacity of the emulsifiers explains their efficiency on moisture retention as mentioned by Seyhun *et al*., (2003).

Staling rate of the cakes containing emulsifiers

Table (5) shows the staling rate of the different cakes containing different emulsifiers during storage at room temperature. The addition of emulsifiers significantly ($P \leq 0.05$) reduced the staling rate in the cakes from the beginning till the end of storage period. This may be attributed to the characteristics of emulsifiers which are applied as antistaling agents related to their interaction with starch,

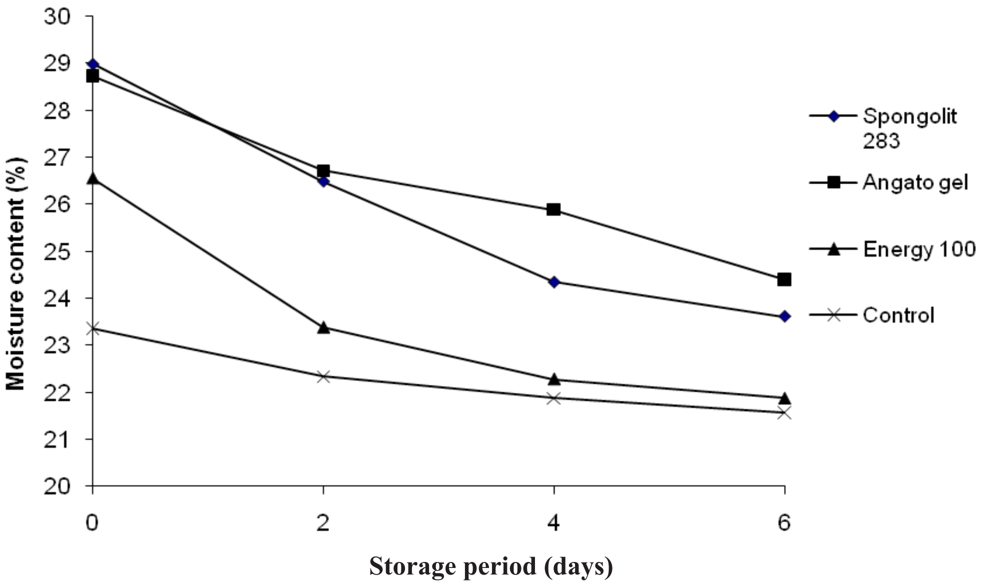

Fig. 3: Effect of different emulsifiers at 3 % on moisture content of cakes during storage

Table 5: Staling rate of the cakes containing different emulsifiers during storage

Treatments	Storage period (days)			
	0	2	4	6
Control	226.5 ± 0.44^{Ad}	205.1 ± 0.33^{Bd}	191.9 ± 0.20^{Cd}	184.1 ± 0.23^{Dd}
Angato gel (3%)	329.1 ± 0.40^{Ab}	322.2 ± 0.78^{Bb}	311.9 ± 0.07^{Cb}	292.1 ± 0.57^{Db}
Energy 100 (3%)	318.5 ± 0.99^{Ac}	308.9 ± 0.35^{Bc}	298.7 ± 0.55^{Cc}	283.0 ± 0.99^{Dc}
Spongolit 283 (3%)	334.0 ± 1.84^{Aa}	327.1 ± 0.42^{Ba}	315.5 ± 1.06^{Ca}	295.8 ± 0.35^{Da}

Data are the mean ± SD, n = 3, Values followed by the same capital letters in the same row; and values followed by the same small letters in the same column are not significantly different (P≤0.05).

particularly with the linear amylose and amylopectin molecules. In this respect, Selomulyo & Zhou (2007) indicated that the formation of these complexes inhibits bread staling either by preventing amylose or amylopectin retrogradation or by having fewer ß-type amylose nuclei that could promote amylopectin retrogradation.

The staling rates reached 334.0, 329.1 and 318.5% for the cakes containing spongolit 283, angato gel and energy 100, respectively at zero time of storage. Meanwhile, it recorded only 226.5% for the control sample at zero time of storage. This finding was because of the components of emulsifiers e.g., the ability of monoglycerides to form complexes with amylose. This amylose monoglycerol inclusion complex is insoluble in water. Therefore, the part of the amylose which is complexed by the monoglycerides does not participate in the gel formation which normally occurs with the starch in the dough during baking. Therefore, upon cooling, the complexed amylose will not recrystallize and will not contribute to staling of the bread crumb (Stampfli & Nersten 1995). Sucrose ester can interact with starch and proteins (Gomez *et al*. 2004) to form complexes, affecting the physical and chemical properties of both ingredients. For starch, sucrose fatty acid esters interact mainly with the amylose molecules to form inclusion complexes with the helical amylose molecules during gelatinization. These complexes inhibit starch retrogradation resulting in a baked product with longer duration freshness (Selomulyo & Zhou 2007).

The lower reduction in the staling rate was achieved in the cakes containing spongolit 283 and then angato gel, since the staling rates reached 295.8, 292.1%, respectively as compared to 283.0, and 184.1% for energy 100 and the control cake, respectively after 6 days of storage.

Weight loss of the cakes containing emulsifiers

The average weight loss (%) values of the cake samples containing different emulsifiers are shown in Fig (4). It could be easily to say that, there was significant ($P \leq 0.05$) difference among the cake samples during storage at room temperature. The control cake lost more moisture than the other cakes which contain different emulsifiers. Angato gel was capable to bind water and also helped in retaining moisture content during storage. So, the cakes containing angato gel exhibited the lower significant ($P \leq 0.05$) weight loss comparable to the other cake samples.

Sensory characteristics of the cakes containing emulsifiers:

The data of sensory attributes of the different cakes with or without emulsifiers are presented in Table (6). The cake samples recorded significantly ($P \leq 0.05$) higher scores than the control in grain, texture and overall acceptability. As shown, the addition of the emulsifiers enhanced all the sensory attributes of the cake samples. These results are conformed to those of Ashwini *et al*., (2009) especially in cell uniformity, flavour, texture and this was reflected in the increase in the overall quality scores being 85.63, 88.75, 89.75 and 96.38 for the control, and the cakes containing angato gel, energy 100 and spongolit 283, respectively. This was attributed to the improving action of the emulsifiers on the sensory characteristics of the cakes; the emulsifiers may bind to the protein hydrophobic surface promoting aggregation of gluten proteins in dough. The addition of Spongolit 283 to the cakes, significantly ($P \leq 0.05$) improved the sensory characteristics of the cakes.

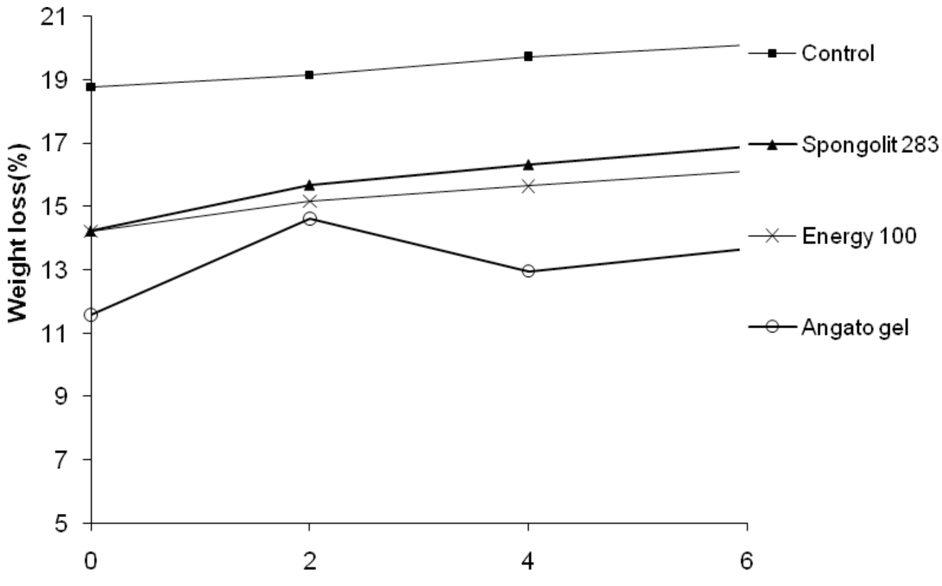

Fig. 4: Effect of different emulsifiers at 3 % on weight loss of the cakes during storage

Table 6: Effect of different emulsifiers on the sensory characteristics of the cakes

Treatments	Cell uniformity (30)	Grain (20)	Texture (30)	Crumb colour (10)	Flavour (10)	Overall acceptability (100)
Control	23.13[b]	16.25[b]	23.50[c]	8.63[a]	9.13[a]	85.63[c]
Angato gel (3%)	24.63[b]	18.63[a]	27.25[b]	9.13[a]	9.13[a]	88.75[b]
Energy 100 (3%)	25.63[b]	18.50[a]	26.87[b]	9.13[a]	9.63[a]	89.75[b]
Spongolit 283 (3%)	28.38[a]	19.50[a]	29.37[a]	9.37[a]	9.75[a]	96.38[a]

Data are the mean, n = 10, Mean values in the same column bearing the same superscript do not differ significantly ($P \leq 0.05$).

CONCLUSIONS

Using different gums and emulsifiers helped retaining moisture and quality properties of the cakes which were effectively improved. The cakes formulated with 0.75% Arabic gum or 3% spongolit 283 had the highest specific volume as compared with the control sample and the other treatments. Addition of xanthan or Arabic gum at 1.0% significantly increased moisture retention and decreased weight loss of the cakes after 6 days of storage at room temperature. Therefore, we found that xanthan, spongolit 283 and angato gel gave more softness and retarding the staling of the cakes than the control cake and other treatment during storage. It could be concluded that the good quality and more freshness microwave-baked cakes can be prepared using 0.75% xanthan as well as 3% spongolit 283.

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تأثير إضافة صموغ و مستحلبات مختلفة على صفات الجودة و معدل البيات للكيك المخبوز فى الميكروويف

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تم دراسة تأثيرات صموغ و مستحلبات مختلفة على جودة الخبيز، الخصائص الحسية و تأخير البيات للكيك المخبوز في فرن الميكروويف. و كانت الصموغ المستخدمة في تحضير مخاليط الكيك هى الزنثان، الصمغ العربى و الكاراجينان كلاً بنسبة ٠,٥، ٠,٧٥ و ١,٠ ٪ بينما كانت المستحلبات المستخدمة هى أنجاتو جل، إنيرجى ١٠٠ و سبونجوليت ٢٨٣ بنسبة ٣٪. ولم يستخدم صموغ أو مستحلبات في تصنيع عينة الكيك المقارنة و التى تم خبزها في فرن الميكروويف. أوضحت النتائج أن الحجم و الحجم النوعى للكيك يزداد زيادة معنوية عند إضافة الصموغ بتركيز ٠,٧٥ ٪ أو إضافة السبونجوليت ٢٨٣ مقارنة بعينة المقارنة. و أن إضافة صمغ الزانثان بتركيز ١,٠ ٪ للكيك المخبوز في فرن الميكروويف أعطى أعلى محتوى رطوبى يليه الكاراجينان و أخيراً الصمغ العربى المضاف بنسبة ١,٠ ٪ بالمقارنة بعينة الكيك المقارنة، أيضاً كان للأنجاتو جل و السبونجوليت ٢٨٣ تأثير فعال في الإحتفاظ بالرطوبة خلال التخزين لمدة ٦ أيام. كما أظهرت النتائج حدوث إنخفاض معنوى في معدل بيات الكيك المخبوز في فرن الميكروويف و ذلك بإضافة صمغ الزانثان بجميع تركيزاته و أيضاً بإضافة السبونجوليت ٢٨٣ يليه أنجاتو جل و إنيرجى ١٠٠ بالمقارنة بعينة المقارنة. و تم الحصول على درجة عالية من القبول الحسى للكيك المخبوز في فرن الميكروويف بإضافة الزانثان يليه الكاراجينان يليه الصمغ العربي عند تركيز ٠,٧٥ ٪، و أيضاً بإضافة السبونجوليت ٢٨٣ ثم أنجاتو جل ثم إنيرجى ١٠٠ و بتحسين معنوى في الخصائص الحسية مقارنة بعينة المقارنة. نستنتج من ذلك أنه يمكن تحضير الكيك المخبوز في فرن الميكروويف بجودة عالية و خصائص حسية أكثر قبولاً و محتوى رطوبي مرتفع وانخفاض في الفقد في الوزن و إطالة فترة الصلاحية و ذلك بإضافة الصموغ والمستحلبات.