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EFFECTS OF DIFFERENT GUMS ON THE SOME PROPERTIES OF FRIED BEEF PATTIES

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ABSTRACT

The aim of the study was to determine the effects of treatments with different gums on fried beef patties. Meat patties were prepared with three different formulations (0.5, 1 and 1.5%) for each of guar gum, xanthan gum, and gum Arabic. Some physical, chemical, and sensorial properties of fried samples were evaluated. As a result, guar gum and xanthan gam showed better effect on yield and diameter reduction. Gum Arabic increased L and b values of fried meat patties whereas guar more increased the moisture retention than others. However, gum Arabic had higher performance on the sensorial properties of beef patties. It was also observed that high levels of gums had much better results as an ingredient in fried patties compared with the other treatments. According to results, it was determined that especially 1.5% level of guar and all level of gum Arabic can be recommended for beef patties.

1. Introduction

Application of various techniques in daily eating foods, including meat products, with decreased levels of fat, cholesterol, and calories, have become a trend for various health reasons. Reduction of fat by using modern technologies would apparently be the most efficient method for producing meat products. In addition there are many technological problems like excessive soft or firm texture, cooking loss and shrinkage are considered by consumers. Regulation of meat product composition with non-meat ingredients can lead to decrease fat value and to improve texture of the final food. The use of these ingredients may increase production yield, sensory properties, and shelf life (Colmenero et al., 1996; Demirci et al., 2014).

Some researchers have reported that different hydrocolloids can increase friction and binding properties among particles and decrease the activity of water in meat products. They can enhance the structure of cooked food decrease texture problems and moisture loss (Ulu, 2004; Modi et al., 2009; Ibrahim et al., 2011; Tabarestani and Tehrani, 2014).

Consequently, some non-meat ingredients have been examined as adjuncts to enhance the quality of meat products during manufacturing (Giese, 1992; Mansour and Khalil 1997; Caprioli et al., 2009; Özen et al., 2011). Especially, when adding different gums at various concentrations in meat batter indicated that the product quality can also be changed (Ulu, 2006; Lopes et al., 2015). Their high water-binding ability is the major functional property of food product. This property affects the texture, enhancement of colour and sensory properties of meat products. Moreover, they are non-allergic and have good mechanical properties and they have wide applications in food production as thickening, stabilizing, gelling, and emulsifying agents (Ulu, 2006; Kilincceker et al., 2009).

It has been found that the addition of gums in meat patty formulations improves the cooking characteristics and also decreases mass transfer and diameter reduction, which results in high yield and improves the thickness of products after frying or cooking (Ulu, 2006; Demirci et al., 2014).

However, compared to the studies on using of different gums in meat patties, studies of other hydrocolloids are many. Thus, the objective of this study was to evaluate the effects of guar gum, xanthan gum and gum Arabic on some frying properties of meat patties and to provide different alternative to consumer.

2. Materials and methods

2.1. Materials

In this study, guar gum, xanthan gum, and gum Arabic were purchased from Kimbiotek Co. (Istanbul, Turkey). Lean beef meat and beef back fat were obtained from local meat seller in Adıyaman. Corn oil was used as frying medium (Yudum, Yudum Co., Balıkesir, Turkey). A mini fryer (Arzum, AR 247) that has a thermostatic heat control was used for carrying out deep frying operations.

2.2. Preparation of meat patties

Meat and fat were cut into 2-3 cm^3 and kept at -18 ^oC until the meat patty production. Then, they were thawed at +4 ^oC and minced using mincing machine, separately. The minced meat was used to prepare the meat batter according to following receipt:

Meat batter was consisted of 87.5% mince, 10% fat, 1.5% salt, 0.5% red pepper, and 0.5% black pepper.

Then, nine different treatments were prepared by adding 0.5%, 1%, and 1.5% gums to the formulation and kneaded and kept at +4 ^oC for up to 45 min. Control did not contain gum. Batters were re-kneaded and each 27 g of batter was shaped with silicone moulds into 14 mm thick and 48 mm diameter circular-shaped patties. Then, patties was used to perform of some frying characteristics at 180 ^oC during 2 min.

2.3. Determination of the frying yield and diameter reduction

Frying yield and diameter reductions after frying were obtained as follows:

$$\text{Frying yield } (\%) = \frac{\text{fried patty weight}}{\text{raw patty weigt}} \text{ x } 100 \quad (1)$$

$$\text{Diameter reduction } (\%) = \frac{\text{raw patty diameter} - \text{fried patty diameter}}{\text{raw patty diameter}} \text{ x } 100 \quad (2)$$

2.4. Determination of the moisture, fat, and moisture retention

Moisture contents of raw and fried samples were determined by oven air method at 105±2 ^oC and fat contents were determined by using soxhlet extraction method (AOAC, 2002). Moisture retention was calculated according to following equation.

$$\text{Moisture retention } (\%) = \frac{\text{moisture in fried patty } (\%)}{\text{moisture in raw patty } (\%)} \text{ x frying yield} \quad (3)$$

2.5. Instrumental colour analysis

Surface colour values of meat patties were measured by using a portable colorimeter (Minolta CR-400, Osaka, Japan) after frying processes for fried samples. The instrument was standardised against a white standardisation plate before each measurement. The colour was maintained according to CIELAB systems as *L* (lightness), *a* (redness) and *b* (yellowness) values, as described by Dogan (2006). Four meat patties were used for the analysis of each treatment. Four measurements were taken for each sample.

2.6. Sensory analysis

The fried patties were coded after 5 min and served in a random order. Ten semi-trained judges assessed the sensory properties using a hedonic scale for the appearance, colour, odour, flavour, and texture scores. The average score of these parameters be deemed to the overall acceptability. Different values in the scale indicated the following reactions: 1: extreme dislike, 2: very much dislike, 3: moderate dislike, 4: slight dislike, 5: neutral, 6:

like slightly, 7: like moderately, 8: like very much, 9: like extremely (Gokalp et al., 1999).

2.7. Statistical analysis

Conventional statistical methods were used to calculate means. The measurements were repeated twice with three replications. Collected data were subjected to statistical analysis using JMP version (JMP version 9.0.2 (SAS Institute, Inc., Cary, USA). Analysis of variance (ANOVA) was used to evaluate effect of gum type and gum concentration on some physical, chemical and sensory properties. Least Significant Differences (LSD) test was used to determine if the effects of factors on the studied parameters were significant ($P < 0.05$).

3. Results and discussions

The frying yields and diameter reductions are shown in table 1. Generally, gums had similar effects on yield and diameter reductions at the low levels. However, guar and xanthan caused higher yield than gum Arabic at high levels. In addition, xanthan gum decreased the diameter reductions of samples at high levels. Addition of gum increased frying yields whereas decreased diameter reductions compared to control. The highest frying yields were calculated as 74.58% and 74.38% in samples with 1.5% guar and xanthan gum. The lowest diameter reductions were in sample with 1% and 1.5% levels of xanthan gum (14.74% and 13.86%). Colour values were presented in table 1. According to results, gum Arabic caused high *L* values on meat patties. However, it had similar results to the *L* values on control. *L* values increased with more gum addition. The highest *L* values were on control and all of samples with gum Arabic (in the range of 26.13-28.04). *a* values of samples were generally similar on samples with gums that are lower than control. However, it was low at 0.5% level of xanthan (4.80). Control, 0.5%, and 1.5% gum Arabic had higher *a* values than other levels in fried samples. Control, xanthan, and gum Arabic increased the *b* values compared to guar gum whereas addition of gum did not affect this colour value. 1% and 1.5% levels of gum Arabic had higher *b* values as 8.32 and 8.31 than other treatments (Table 1).

Table 1. Effect of gum type and concentration on yield, diameter reduction, and colour values of fried beef patties

	Gum type	**Gum concentration**			
		Control (0%)	0.5%	1%	1.5%
Yield (%)	Guar	68.31^{aBC}	66.36^{aC}	70.84^{bB}	74.58^{aA}
	Xanthan	68.31^{aB}	67.19^{aB}	73.93^{aA}	74.38^{aA}
	Gum Arabic	68.31^{aBC}	66.15^{aA}	67.24^{cA}	66.26^{bA}
Diameter Reduction (%)	Guar	20.92^{aA}	18.51^{aA}	19.71^{aA}	16.88^{abA}
	Xanthan	20.92^{aA}	21.63^{aA}	14.74^{bB}	13.86^{bB}
	Gum Arabic	20.92^{aA}	17.70^{aC}	18.54^{abBC}	19.48^{aB}
L	Guar	26.13^{aA}	23.64^{bC}	23.77^{aC}	24.65^{abB}
	Xanthan	26.13^{aA}	20.20^{cC}	22.51^{aBC}	24.37^{bAB}
	Gum Arabic	26.13^{aA}	27.36^{aA}	27.25^{aA}	28.04^{aA}
a	Guar	6.57^{aA}	5.66^{aB}	5.83^{aB}	5.82^{aB}
	Xanthan	6.57^{aA}	4.80^{bC}	5.86^{aB}	5.71^{aB}
	Gum Arabic	6.57^{aA}	6.08^{aAB}	5.57^{aB}	6.11^{aAB}
b	Guar	6.95^{aA}	6.44^{bA}	6.49^{bA}	6.98^{aA}
	Xanthan	6.95^{aA}	6.71^{abA}	7.41^{abA}	7.67^{aA}
	Gum Arabic	6.95^{aA}	7.81^{aA}	8.32^{aA}	8.31^{aA}

$^{a-c}$ Within each column, different superscript lowercase letters show differences between the gum types within each concentrate ($P < 0.05$); $^{A-C}$ Within each row, different superscript uppercase letters show differences between the concentrations within each gum ($P < 0.05$).

Moisture and fat rations of raw and fried patties were shown in table 2. Also, moisture retentions that calculated from these were presented in this table. Control and gum Arabic increased the moisture rations of raw samples whereas addition of gum decreased this value. The highest moisture values for raw samples were determined in sample with control and 0.5% gum Arabic as 64.50% and 64.70%. Gum Arabic more decreased the fat rations in raw sample than with guar and xanthan gum. Especially, samples with levels of 0.5% and 1.5% gum Arabic had lower fat rations than other samples as 12.46% and 12.36%. Generally, addition of gum decreased the fat rations in raw meat patties. As in raw sample, moisture rations of fried samples with gum Arabic and control generally higher than other fried patties. However, moisture increased at 1.5% level of guar gum in patties (56.25%). Addition of gum increased the moisture rations in fried sample with guar and gum Arabic whereas caused fluctuation change in with xanthan gum. Guar gum and gum Arabic more decreased the fat rations in fried meat patties. Also, addition of gum decreased fat rations in these samples. The lowest fats were determined in sample with 1.5% guar and 0.5% gum Arabic as 11.31% and 12.32%, respectively. Moisture retentions affected from types and addition of gums. Especially, guar and xanthan caused good results in fried samples. Generally, moisture retention increased with more gum addition in fried samples. This values for 1.5% levels of guar gum and xanthan gum in meat patties were determined to be higher compared with other treatments (Table 2).

Table 2. Effect of gum type and concentration on moisture, fat, and moisture retention values of fried beef patties (%)

		Gum type	**Gum concentration**			
			Control (0%)	0.5%	1%	1.5%
Raw samples	Moisture	Guar	64.50^{aA}	63.72^{bA}	63.63^{aA}	61.47^{aA}
		Xanthan	64.50^{aA}	64.08^{bA}	63.78^{aA}	60.58^{aB}
		Gum Arabic	64.50^{aA}	64.70^{aA}	62.20^{aB}	61.41^{aB}
	Fat	Guar	14.37^{aA}	14.56^{aA}	14.25^{aA}	13.77^{aA}
		Xanthan	14.37^{aA}	13.64^{abAB}	12.95^{aB}	13.32^{aAB}
		Gum Arabic	14.37^{aA}	12.46^{bB}	13.70^{aA}	12.36^{aB}
Fried samples	Moisture	Guar	54.76^{aB}	52.53^{bC}	54.73^{bB}	56.25^{aA}
		Xanthan	54.76^{aA}	48.65^{cC}	53.19^{cAB}	52.57^{bB}
		Gum Arabic	54.76^{aB}	56.50^{aA}	56.54^{aA}	55.79^{aAB}
	Fat	Guar	13.73^{aAB}	14.68^{aA}	12.48^{bBC}	11.31^{bC}
		Xanthan	13.73^{aB}	16.27^{aA}	16.78^{aA}	16.98^{aA}
		Gum Arabic	13.73^{aA}	12.32^{bB}	12.77^{bAB}	12.86^{bAB}
Moisture retention		Guar	58.00^{aBC}	54.71^{abC}	60.95^{aB}	68.24^{aA}
		Xanthan	58.00^{aB}	51.02^{bC}	61.65^{aAB}	64.56^{abA}
		Gum Arabic	58.00^{aA}	57.77^{aA}	61.13^{aA}	60.21^{bA}

$^{a-c}$ Within each column, different superscript lowercase letters show differences between the gum types within each concentrate ($P < 0.05$); $^{A-C}$ Within each row, different superscript uppercase letters show differences between the concentrations within each gum ($P < 0.05$).

Data in table 3 indicate that fried meat patties formulated with gums were affected from types and addition of gum for appearance, colour, texture, and overall acceptability whereas they were not affected for odour. In addition, taste scores were not affected from the addition of gums. Control and samples with gum Arabic had higher appearance than other treatments. Addition of gum increased the appearance values in sample with gum Arabic. Generally, addition of guar and xanthan decreased this value compared to control (Table 3). Control and all level of gum Arabic caused higher appearance scores than other samples (in the range of 7.00-7.90). Colour scores on control and samples with guar and gum Arabic were high. Addition of gum did not affect this value for guar and gum Arabic whereas increased for xanthan. 1.5% guar, and 0.5, 1, and 1.5% gum Arabic caused the higher colour scores than other treatments (in the range of 7.20-7.50). Taste scores increased with guar gum and gum Arabic whereas addition of gum did not affect this value. The highest values were in sample with 1.5% guar (7.00) and all level of gum Arabic (in range of 7.00-7.80). Textures of fried patties with guar gum, gum Arabic and control were better than xanthan whereas this value did not affected from addition of gum. All level of guar, gum Arabic, and control were similar, statistically (in range of 6.30-7.40). Generally, overall acceptability values were higher in samples with guar, gum Arabic and control than xanthan. Addition of gum did not affect the overall acceptability for sample with guar and gum Arabic. The highest results were in sample with 1.5% guar, all level of gum Arabic, and control as 6.86, 6.88, 7.28, 7.34, and 6.48 (Table 3).

Table 3. Effect of gum type and concentration on sensory properties of fried beef patties

	Gum type	**Gum concentration**			
		Control (0%)	0.5%	1%	1.5%
Appearance	Guar	7.00^{aA}	6.50^{aB}	6.00^{bC}	6.40^{bBC}
	Xanthan	7.00^{aA}	3.30^{bB}	3.40^{cB}	3.80^{cB}
	Gum Arabic	7.00^{aB}	7.30^{aB}	7.90^{aA}	7.80^{aA}
Colour	Guar	6.60^{aA}	6.20^{aA}	6.50^{aA}	7.20^{abA}
	Xanthan	6.60^{aA}	4.60^{bC}	5.10^{bBC}	5.80^{bAB}
	Gum Arabic	6.60^{aA}	7.20^{aA}	7.50^{aA}	7.40^{aA}
Odour	Guar	5.70^{aA}	5.30^{aA}	6.40^{aA}	6.30^{aA}
	Xanthan	5.70^{aA}	4.80^{aA}	4.90^{aA}	4.80^{aA}
	Gum Arabic	5.70^{aA}	6.00^{aA}	6.60^{aA}	6.50^{aA}
Taste	Guar	5.80^{aA}	6.60^{abA}	5.80^{bA}	7.00^{aA}
	Xanthan	5.80^{aA}	5.40^{bA}	5.20^{bA}	4.40^{bA}
	Gum Arabic	5.80^{aA}	7.00^{aA}	7.70^{aA}	7.80^{aA}
Texture	Guar	7.3^{aA}	6.40^{aA}	6.30^{abA}	7.40^{aA}
	Xanthan	7.3^{aA}	4.60^{bB}	4.90^{bB}	4.80^{bB}
	Gum Arabic	7.3^{aA}	6.90^{aA}	6.70^{aA}	7.20^{aA}
Overall acceptability	Guar	6.48^{aA}	6.20^{aA}	6.20^{bA}	6.86^{aA}
	Xanthan	6.48^{aA}	4.54^{bB}	4.70^{cB}	4.72^{bB}
	Gum Arabic	6.48^{aA}	6.88^{aA}	7.28^{aA}	7.34^{aA}

$^{a\text{-}c}$ Within each column, different superscript lowercase letters show differences between the gum types within each concentrate ($P < 0.05$); $^{A\text{-}C}$ Within each row, different superscript uppercase letters show differences between the concentrations within each gum ($P < 0.05$).

Discussions

The frying yield and diameter reduction are important factors for manufacturers. They are results of the deneration of meat protein. They affect the economic profit and packaging system. Gelatinization and water holding capacity of gums affect them (Ulu, 2006; Demirci et al., 20014). Modi et al. (2009) determined that carrageenan gum increase frying yields and decrease diameter reductions of meat kofte. Also, they found that addition of carrageenan more increase the frying yields and decrease diameter reductions. They said that this could be due to the binding property of carrageenan which caused to form complex with water and protein. Thus, they decrease the mass transfer and retain the shape of kofte. In our study, guar gum and xanthan gum shown similar effect in this study. Gibis et al. (2015) found that moisture loss decrease with increasing addition of microcrystalline cellulose from 0.5% to 3% in fried beef patties. In another study, beef burgers were produced with *Aloe vera* in the range of 0-5% and their properties were determined. Consequently, *Aloe vera* acts as a hydrocolloid and decreased cooking losses and diameter reductions of burgers. Also, it determined that increase of concentration of *Aloe vera* contributed to decrease of cooking loss and diameter reductions. They reported that increasing of yield and diameter resulted from the high water holding capacity and moisture retention of *Aloe vera* during cooking (Soltanizadeh and Ghiasi-Esfahani, 2015). Colour values are important factors in consumer choice. They can be affected by the ingredients in patties and the frying process. As in our study, Demirci et al. (2014) reported that *L* values of meatballs affected from gum types and increased with the gum addition in formulations. Also, Yasarlar et al. (2007) said that *L* values of cooked samples resulted differently in cooked meatballs with various cereal bran and increased with more bran addition on samples. Khalil (2000) determined that low-fat patties formulated with starch/water combinations had lower red colours compared with the control. Yasarlar et al. (2007) found that *a* value of cooked meatballs affected from type of cereal bran and decreased with more bran addition. Demirci et al. (2014) reported that meat ball redness decreased and yellowness increased with more gum addition in cooked samples whereas *a* and *b* values changed depending on gum types. In addition, similar findings were also reported by Lin and Huang (2003) and Yılmaz and Dağlıoğlu (2003) also.

Moisture ration of low level of gum Arabic in raw meat patties was higher than other and this can be connected with water binding of it. The level of moisture in the raw samples decreased when the level of xanthan and gum Arabic increased in meat patties. Accordingly, at 0.5% level of gum Arabic and addition of xanthan and gum Arabic decreased the fat rations in raw samples compared to control. Similar findings have also been previously reported for various types of meat products such as patties (Khalil, 2000; Yilmaz and Dağlıoğlu, 2003; Yasarlar et al., 2007; Demirci et al., 2014).

In fried patties, lower moisture values of samples with xanthan were due to more friable structure than with guar and gum Arabic that was also observed by the panellist during work. Demirci et al. (2014) also found that a reduction in the moisture of cooked meatballs formulated with xanthan gum compared to guar, carrageenan, and locust bean gums. Especially, addition of guar gum increased the moisture rations in fried samples whereas samples with gum Arabic did not affected from addition gum. As the raw patties, this resulted from water binding ability of guar and gum Arabic. The gums form a firm matrix and prevent the migration of moisture from fried food and the penetration of fat in it during frying. Also, fat can be partly replaced by water and non-meat ingredients such as the gums (Demirci et al., 2014). Guar and gum Arabic had lower fat values because of high moisture rations in fried samples. Especially, high level of these gums prevented the moisture loss of fried patties and decreased fat absorption. Friable structure of samples with xanthan also increased moisture loss and fat absorption inside it during frying. Similarly, Yilmaz (2004) reported that the most effective method in lowering calorie content is decreasing fat content in meat products. In addition, he found that addition of rye bran at the level of 20% in meat balls resulted in a significant reduction in fat content compared with 5%, 10%, and 15% levels. Our results agree with those reported by Mansour and Khalil (1997) and Soltanizadeh and Ghiasi-Esfahani (2015), who reported significantly decreased fat contents for beef burgers with added dietary fibre and *Aloe Vera* in different rations to reduce the fat content, respectively.

Sensory properties have also effect on the attractiveness of foods and consumer preference such as colour attributes. Thus, they should be determined in the new product. Control and all of samples with gum Arabic had higher appearance scores than other patties. This can be connected with *L* values of samples that were higher than with guar and xanthan. As the appearance, colours can be also affected from *L* values of the patties. Increasing of lightness provided a bright colour formation and raised preferential ability of the product visually. Decrease of appearance and colour with addition of guar gum may be resulted from decrease of *L* and *a* values on these patties. They created a dark colour on meat patties. Increasing of taste scores in sample with 1.5% guar and all of samples with gum Arabic may be resulted with fat values of these patties. Generally, fat rations of these samples lower than other fried samples. Consequently, low rations of fat reduced the formation of a heavy fatty taste which was noted by panellist. Textures of control and sample with guar and gum Arabic were very good compared to samples with xanthan. Textures of these samples may be improved with moisture ration of fried patties. Especially, 1.5% guar and all of samples with gum Arabic contained higher moisture compared to other patties. Moisture of these samples caused to form juicy and softer structure and increased texture scores. Decreasing of texture with addition of xanthan connected with their friable structure. Similar results were determined by Demirci et al. (2014) for meatballs containing different gums, Ibrahim et al. (2011) for chicken burger containing maltodextrin and potato starch and Yilmaz (2005) for low-fat meatballs prepared with wheat bran. In addition, Mansour and Khalil (1997) reported that the addition of wheat fibres can be used to make acceptable and desirable low fat beef burgers. The overall acceptability values supported the sensory properties of meat patties and high sensory scores caused the increasing of this value. Yilmaz (2004), and Mansour and Khalil (1997) also found similar results in their studies.

4. Conclusions

The study shows that the use of gums can enhance the quality of beef meat patties during frying. As a result, the performance of gums on patties increased with the addition of their more amounts. Especially, 1.5% guar and all levels (0.5, 1, and 1.5%) of gum Arabic are suitable alternative to produce good quality meat patties with better sensory acceptability for frying processes. Therefore, the addition of these gums and the specified levels in meat patties are more advantageous than other treatments during manufacturing.

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