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TRIALS FOR IMPROVING BEEF BURGER QUALITY USING SOME NATURAL ADDITIVES AS ALTERNATIVES TO CHEMICAL PHOSPHATE

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ABSTRACT

Nowadays natural preservative replacers are being used as alternatives to synthetic ones. As these natural replacers could maintain product quality, keep the same technological effects, improving sensory properties and increasing shelf-life resulting in healthy food and keeping human health. So, this study was investigated for using guar gum (GG), gum Arabic (GA) and milk calcium (MC) at a concentration of 0.3% and 0.5% as a phosphate replacer (0.3% Na2HPO4) and evaluated its effect on physicochemical, microbial and sensorial properties of beef burger. The results showed that GG (0.5%) and GA (0.5%) were the best natural preservatives replacer as they achieved the lowest APC and *S. aureus* count (3.6±0.1, 3.2±0.03, 2.16±0.02 and 2.56±0.04 log cfu/g), respectively. While GG (0.5%) had the complete inhibitory effect on *E. coli* count. Also, cooking loss significantly decreased due to the adding of gums in compared to control group and the fried burger with GA (0.5%) had the lowest cooking loss percentage by 30% in relation to pH among the studied groups. Sensorially, all parameters analyzed were not affected by the replacement of Na2HPO4 by the different concentration of gum and milk calcium. The use of GG, GA and MC is a viable alternative to be used as Na2HPO4 replacers in the preparation of beef burgers.

KEYWORDS: Guar gum (GG), Gum Arabic (GA), Milk calcium (MC), APC, *E. coli* and *S. aureus.*

1-INTRODUCTION

Meat is considered an integral part of human nutrition, which considered good sources of protein, essential amino acids, fatty acids, vitamins, and minerals. It provides energy for growth and is involved in various biochemical, metabolic, and physiological activities **(Kausar et al. 2019).** Meat products are widely consumed worldwide due to their nutrition, taste, flavor, and attractive color. By 2020, global meat consumption amounted to approximately 330 million tons and it is estimated to increase to 370 million tons by 2030 (**Whitton et al. 2021).** However, the increase in meat production is an unsustainable process that can lead to environmental problems, such as water depletion, climate change, deforestation, pollution, damage to hydrological and geological reserves, and loss of biodiversity (**Fiorentini et al. 2022).** There are many technological problems that are recognized by consumers like excessive softness or firmness in texture, cooking loss and shrinkage. Controlling meat product composition with non-synthetic chemical ingredients as natural additives can lead to enhance fat and meat value and to improve texture of the final meat products. These ingredients may improve production yield, sensory properties, and shelf life **(Demirci et al. 2014).**

Phosphates are widely used as food additives as they support the processing properties and functional characteristics of meat, poultry, and their products. They are used to improve the water holding capacity (WHC) through increasing pH of the products, antimicrobial effect, prevent lipid oxidation, decrease cooking loss and subsequently increase the cooking yield, improving color of meat products and keeping their textural properties **(Sebranek 2015).** Phosphates in combination with its salts can improve protein function and increase the ionic strength, resulting in reducing cooking loss of the product **(Sindelar 2015)**. Although, phosphates have multifunctional benefits, it has been getting way to the end of its use in the recent decade because of poor consumer perception associated with health risks. (**Kim et al. 2017).**

Recently, scientists are searching for alternatives to phosphate from natural sources **(Cho et al. 2017).** Addition of variance types of gums with different concentrations in meat batter result in positively outstanding changes **(Lopes et al. 2015).** Their high water-binding ability is the major functional property for improving the texture, color and sensory properties of meat products. Moreover, they are also non-allergic and have good mechanical properties and they have wide applications in food production as thickening, stabilizing, gelling, and emulsifying agents **(Kilincceker et al. 2009).** Guar gum is widely used in the food industry, it is also act as emulsifies, and binds water to prevent ice crystal in a frozen product and postpone many liquid and solid systems. Also, various types of research have shown that this GG reduces blood cholesterol and controls obesity and type 2 diabetes (**Dehghani Soltani et al. 2021)**. Guar gum has antimicrobial properties, and can be used in edible films and coatings. It is also characterized by containing antimicrobial agents potentially prolongs the shelf life of food and modifies the film features **(Kumar et al. 2021).** Guar gum reduces peroxide in the products causes an increase in the products shelf life because of its stabilizing properties and prevention of fat breakdown, also it increase water absorption and viscosity **(Pourfarzad and Yousefi 2020).** Guar gum (GG) has high content of dietary fibers, so it is used in preparation of low glycemic food products. Guar gum is a natural polysaccharide with a high molecular weight which is symbolized by E412 in European additives which is used in a wide range of food industries, medical, pharmaceutical, textile, paper, agriculture, cosmetics, and bioremediation **(Gupta and Variyar 2018).** Guar gum can collect a large quantity of water, resulting in high viscosity that is responsible for its adhesion to the hydrophilic surfaces. Guar gum products affected by temperature, this is the reason for losing water of hydration around the polymer molecule which makes the GG most applicable as natural polymer **(Reddy and Tammishetti 2006).** Moreover, Guar gum has a very important role in imparting a slick creamy mouth feel which mimics fat and is being used in low fat restructured meat products **(Rather et al. 2016).**

Gum Arabic is being widely used for industrial purposes such as a stabilizer, thickener, emulsifier, and used as encapsulating form in food industry and to a lesser extent in textiles, ceramics, lithography, cosmetic and pharmaceutical industry **(Mariana et al. 2012).**Gum Arabic (GA) is edible, dried, gummy polysaccharide derived from the stems and branches of Acacia Senegal and Acacia seyal trees which is rich in non-viscous soluble fiber **(Abdul-Hadi et al. 2010).** Natural calcium powder, that are widely used and distributed in the food industry, including oyster shell calcium (OSC), eggshell calcium (ESC), marine algae calcium (MAC), and milk calcium (MC). Each one of these natural calcium powder has its own physico-chemical properties and sensory characteristics, because they differ in their basic sources from raw materials and manufacturing methods. They are used for replacement of synthetically chemical preservatives **(Bae et al. 2017).** Therefore, the aim of the present study was to determine the ability of natural additives replacer (guar gum, gum Arabic and milk calcium) to improve quality of beef burger and substitute chemical phosphate.

2-MATERIAL AND METHODS

A-The additives used in the experiment

Guar gum (GG) **and Milk Calcium (MC)** were obtained from El- Gomhoria Chemicals Company at Tanta Governorate.

Gum Arabic: Gum Arabic (Acacia Senegal, Hashab) in powder form was obtained from Faculty of science, Tanta University.

Dibasic Anhydrous Purified Sodium Phosphate (Na2HPO4), Laboratory Chemicals MR 177.99, Assay (80%) was obtained from Faculty of science, Tanta University.

B-Preparation a solution from additives according to Srichamroen (2007)

Aqueous solutions of (0.3% and 0.5%) this concentration which approved by **(US-FDA, 2019)** were prepared on (w/v) using a boiling water bath for 30 min, with gentle stirring to produce homogenized solution. These solutions were cooled and kept at 4^{o}C for 2 h.

C-Burger preparation

One sample weighted two kg of fresh beef meat was purchased from butcher shop in Tanta, Gharbia governorate transferred under strict hygienic measures to the laboratory as soon as possible, beef burger samples were manufactured according to **Aleson-Carbonell et al. (2005)** by mincing beef meat (65%), with addition of ice water, kidney fat (15%) and other ingredients (spices mixture 2.5%, salt 2 %, dried onion 2.5 % and dried garlic 2.5 %). Prepared sample was divided into eight sub-groups (250 g for each) and treated as follows: The 1st group (C): control without any treatment, The 2nd group was treated by addition of 0.3% Na2HPO4, The 3rd and 4th groups were treated by 0.3% and 0.5% of GG, respectively, The 5th and 6th groups were treated by 0.3% and 0.5% of GA, respectively. The 7th and 8th groups were treated by 0.3% and 0.5% of MC, respectively. Then mix again for 5min. to create homogenate mixture, each 27g was shaped with silicone molds into 14 mm thick and 48 mm diameter circular-shaped patties. These patties were placed on plastic foam meat trays and wrapped with polyethylene film then kept frozen at (-18˚c) until further examinations. The experiment was repeated in triplicate.

D-Chemical analysis

***Determination of pH**

Ten grams of raw beef burger samples were homogenized and mixed thoroughly with 100 mL of distilled water for measuring of pH using a digital pH meter (Suntex TS-1, Taiwan) by direct immersion of electrode into the mixture at room temperature according to **AOAC (2002).**

***Determination of moisture content**

Moisture contents of raw beef burger samples were determined by hot air oven method at 105±2°C according to **AOAC (2002).**

E-Bacteriological examination

***Preparation of sample homogenate (APHA, 2001)**

Twenty-five grams of the examined beef burger samples were aseptically transferred into a sterile homogenizer flask with 225 ml sterile buffered peptone water (0.1%) then homogenized at 2000 rpm for 1-2 mint to give an initial dilution of 1/10. One ml from this initial dilution was transferred to another sterile tube containing 9 ml of sterile buffered peptone water (0.1%) then mixed to obtain the next dilution (1:100). Repeat this operation up to10.[6]

***Aerobic plate count (APC) according to ISO 4833-2:2013**

From the previously prepared serial dilutions, 0.1 ml of each dilution was spread onto the surface of Standard Plate Count Agar (Oxoid, CM0463) and incubated at 37°C for 48±2h; colonies were counted and recorded as $\log_{10}$ cfu/g.

****E-coli* count according to ISO 16649/1(2018)**

From the previously prepared serial dilutions, 0.1 ml of each dilution was spread over Eosin Methylene Blue agar plate using sterile bent glass speeder's plates were inverted and incubated at 37°C for 48±2h., *E. coli* appear on EMB agar as (blue-black colony with a greenish metallic sheen). Results were calculated as $\log_{10}$ cfu/g.

****S. aureus* count according to FDA (2001)**

From the previously prepared serial dilutions, 1 ml was spread over the surface of three Baired Parker agar plates (0.3, 0.3 &0.4 ml) using sterile bent glass spreader. The plates were inverted and incubated at 37°C for 48±2h., *S. aureus* appear as black, shiny, circular, smooth and convex with narrow white margin and surrounded by a clear zone were counted and recorded as cfu/g sample.

F-Physical examination

***Determination of cooking loss according to (Bae et al. 2017)**

Weight of each raw beef burger sample before frying and then after frying. The beef burger samples were fried on an electrical hot plate at 180˚c or for about 5 min for each side, **Khalifa (2011)** and cooling to calculate the cooking loss.

$$\text{Cooking loss (\%)} = \frac{\text{Weight before cooking} - \text{Weight after cooking}}{\text{Weight before cooking}} \times 100$$

G- Sensory analysis

Sensory evaluation was carried out by a ten-member well trained panelist. Panel members were from the Food Hygiene Department, Animal Health Research Institute, Tanta Branch. Panelists were asked to evaluate each group for color, odor, texture and overall acceptability for raw groups. The same parameter plus taste for fried groups on a 5-point hedonic scale according to **Pelin-Can and Arslan (2011).**

H-Statistical analysis

Statistical analyses were run in triplicate and results were reported as mean values and standard deviation (Mean±SD). Use of Statistical Packaging for Social Science (SPSS) Ver. 20. A p-value less than 0.05 ($p \leq 0.05$) was considered statistically significant.

3. RESULTS

Physico-chemical criteria of raw and fried control and treated beef burger samples

In the current study using of natural additives as guar gum, gum arabic and milk calcium with different concentration (0.3 and 0.5%) as replacer to chemical phosphate 0.3%. The result in **Table (1)** showed a clear significance differences (P≤0.05) in pH of control beef burger sample (5.97±0.08) and samples treated with 0.3% Na2HPO4 (6.1±0.03), 0.5% GG (6.13±0.08) and 0.5% GA (6.13±0.08). Meanwhile, significance differences were not existed (P > 0.05) in pH between control and treated beef burger samples with 0.3% GG (6±0.1), 0.3% GA (6±0.1), 0.3% MC (6±0.06) and 0.5% MC (6±0.11) when compared to control samples.

Also the result showed a clear significance differences (P ≤ 0.05) in moisture of control beef burger sample (43.9±0.5) and samples treated with 0.3% Na2HPO4 (45.1±0.12) and 0.5% GA(44.9±0.3), but 0.5% GG had the highest moisture(45.87±0.3). While there were no significance differences (P > 0.05) between control and treated samples with 0.3 %GG (43.1±0.57), 0.3% GA (43.13±0.9), 0.3 %MC (42.3±0.7) and 0.5% MC (42.8±0.6).

When beef burger samples had fried there were a clear significance differences (P ≤ 0.05) in pH of control beef burger sample (6.06±0.05) and samples treated with 0.3% Na2HPO4 (6.3±0.05), 0.5% GG (6.3±0.05), and 0.5% GA (6.36±0.08). Meanwhile, significance differences were not existed (P > 0.05) in pH of control and other beef burger samples treated with 0.3% GG (6.1±0.03), 0.3%MC (6.1±0.08), and 0.3% GA (6.26±0.1) and 0.5% MC (6.2±0.05).

Our results showed a relation between pH and cooking loss as the higher pH, the lower cooking loss. There were a clear significance differences (P ≤ 0.05) in cooking loss of control fried beef burger sample (8.43±0.04) and those treated with Na2PHO4 (7.51±0.1, 30.04%), 0.5% GG (7.57±0.03, 30.28%) and0.5% GA (7.50±0.07, 30%). Meanwhile, significance differences were not existed (P > 0.05) in context of cooking loss between control fried beef burger samples and other treated samples.

Table 1: Mean values of chemical and physical finding of control and treated beef burger samples by using different natural replacer.

Treatment		Chemical finding of raw control and tread samples		Physico-chemical finding of fried samples		
Additives groups	Concentration	pH	Moisture	pH	Cooking loss	
					Amount (g)	%
Control	-----	5.97±0.08^{A}	43.9±0.5^{B}	6.06±0.05^{C}	8.43±0.04^{D}	33.72
Na2PHO4	0.3%	6.1±0.03^{a}	45.1±0.12^{b}	6.3±0.05^{c}	7.51±0.1^{d}	30.04
GG	0.3%	6±0.1^{A}	43.1±0.57^{B}	6.1±0.03^{C}	7.91±0.05^{D}	31.64
GG	0.5%	6.13±0.08^{a}	45.87±0.3^{b}	6.3±0.05^{c}	7.57±0.03^{d}	30.28
GA	0.3%	6±0.1^{A}	43.13±0.9^{B}	6.26±0.1^{C}	7.88±0.02 ^{D}	31.52
GA	0.5%	6.13±0.08^{a}	44.9±0.3^{b}	6.36±0.08^{c}	7.50±0.07^{d}	30.00
MC	0.3%	6±0.06^{A}	42.3±0.7^{B}	6.1±0.08^{C}	7.95±0.09^{D}	31.80
MC	0.5%	6±0.11^{A}	42.8±0.6^{B}	6.2±0.05^{C}	7.93±0.05^{D}	31.72

N. B: * Tested burger samples 25 g of each * Mean difference was significant at P<0.05 between the superscripted small and capital letters in the same column for all treatments.

Bacteriological findings of control and treated beef burger samples

The result in Table (2) showed the mean bacterial count (log_{10} cfu/g) of control and treated beef burger samples. Addition of both GA and GG (0.5%) reduced the mean APC from 4.66±0.08 log_{10} cfu/g of control to (3.2±0.03 and 3.6±0.1), followed by 0.5% MC (3.7±0.1) and 0.3% GA (3.9±0.2), then 0.3% of both GG and MC (4.1±0.3 and 4.1±0.04) and finally 0.3% disodium phosphate (4.4±.0.1). Meanwhile, significance differences were existed (P<0.05) in mean APC between control and only the sample treated with 0.5% of both GG, GA & MC. *E. coli* count was completely inhibited (Not detected) after addition of 0.5% GG, while addition of GG 0.3%, GA 0.5% and GA 0.3% had a significant reduction of *E. coli* count (1.1±0.01, 1.49±0.07 and 1.56±0.01 log cfu/g) as compared with the control sample (2.4±0.2 log cfu/g) but sample treated with Na2PHO4 recorded 1.8±0.1 log cfu/g of *E. coli* count, which meaning no significance differences (P>0.05) in *E. coli* count of control and that treated with of Na2HPO4 0.3%. 0.3%MC and 0.5% MC (1.68±0.02). Furthermore, *S. aureus* count was decreased from (2.9±0.03 log cfu/g) of control to (2.16±0.02 log cfu/g) by addition of GG 0.5%, followed by GA 0.5% (2.65±0.06 log cfu/g) and Na2HPO4 0.3% (2.5±0.04 log cfu/g) then GG 0.3% (2.65±0.06 log cfu/g), GA 0.3% (2.7±0.05 log cfu/g) and finally, MC 0.3% and 0.5% (2.9±0.08) for both. The result showed there were no significance differences (P > 0.05) in *S. aureus* count of control and treated samples with 0.3% of both GG & GA as well as 0.3% and 0.5% MC (2.9±0.08 log cfu/g). While the significance difference in *S. aureus* count was revealed between control and only samples treated with 0.3%, Na2PHo4, as well as 0.5% of both GG & GA.

Table 2: Mean microbial counts (log10 cfu/g) of control and treated beef burger samples using different natural replacer.

Treatment		Microbial finding		
Additives groups	Concentration	APC	*E. coli*	*S. aureus*
Control	-----	4.66±0.08^{A}	2.4±0.02^{B}	2.9±0.03^{C}
Na2PHo4	0.3%	4.4±0.01^{A}	1.8±0.01^{B}	2.5±0.04c
GG	0.3%	4.1±0.03^{A}	1.1±0.01^{b}	2.65±0.06C
GG	0.5%	3.6±0.01 ^{a}	-----	2.16±0.02^{c}
GA	0.3%	3.9±0.02^{A}	1.56±0.01^{b}	2.7±0.05C
GA	0.5%	3.2±0.03^{a}	1.49±0.07^{b}	2.56±0.04c
MC	0.3%	4.1±0.04^{A}	1.86±0.01^{B}	2.9±0.08C
MC	0.5%	3.7±0.01^{a}	1.68±0.02^{B}	2.9±0.08C

N. B The mean difference was significant at P<0.05 level between all treatments

Sensory characters of raw and fried beef burger samples

Data in **figure (1 and 2)** indicated that beef burger samples prepared with adding GG, GA, MC and Na2pHo4 were affected for color, odor, texture, and overall acceptability whereas color scores of control and beef burger samples treated with GG and GA were high. They were not affected for odor. Generally, overall acceptability values were higher in samples treated with Na2PHO4, GG, GA and control than other treatment. Textures of fried beef burger samples with GG, GA and control were better than other treatment. Beef burger samples with GG and GA had the highest taste scores. The good results were in sample with 0.5% GG and 0.5%, 0.3% of GA, and control as shown in **figure (1 and 2).**

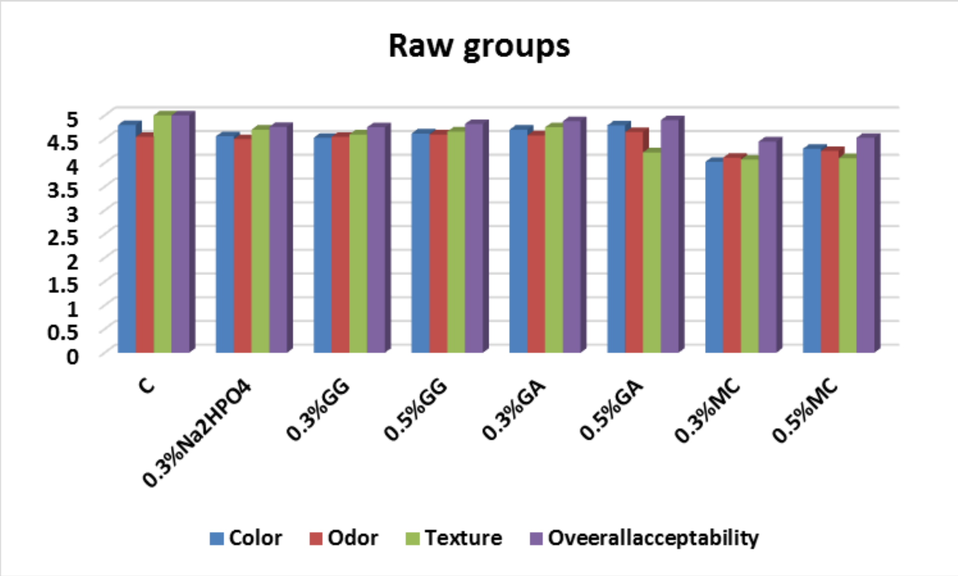

Fig.1: Sensory analysis for raw beef burger samples. Values are the means of three individual replicates), C: control group without any treatment.

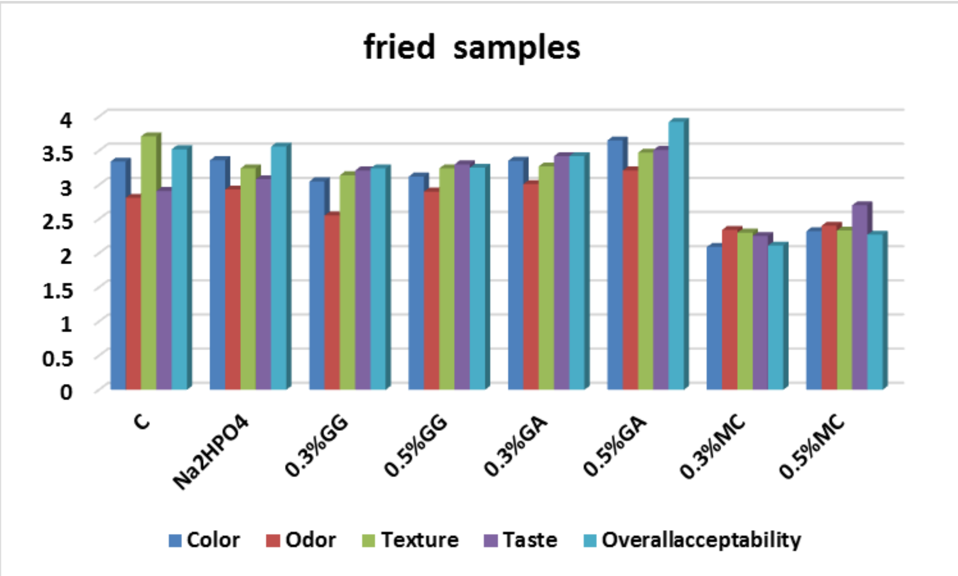

Fig.2: Sensory analysis for fried beef burger samples. Values are the means of three individual replicates), C: control group without any treatment.

4. DISCUSSION

Natural preservatives as Guar gum (GG), Gum Arabic (GA) and milk calcium (MC) are preferable to be used as replacers for the synthetic Na2HPO4 in meat products, which improves the quality of the product by retaining water, as the loss of water leads to shrinkage of the product and a significant economic loss for producers and manufacturers. Therefore, it retaining of moisture, which resulted in decreasing of cooking loss, increasing the cooking yield and increasing the product palatability and protect the consumer health from the side effect of synthetic or chemical preservatives **(El-Shinawy and Abdelmonem 2020).** Hydrogen ion concentration (pH) value is the most important factor that affects several characteristics of meat products including texture, water holding capacity (WHC), color, and shelf life **(Hashem et al. 2011).** The obtained results agreed with **El-Shinawy and Abdelmonem (2020)** who concluded that no significant differences ($P \leq 0.05$) in pH of samples treated with 0.3% Na2HPO4 and 0.5% GG. The results were in harmony with **Jeong (2016)** who reported that there was no significance difference ($P>0.05$) between pH of control samples and samples treated with MC. It was clear that 0.5% GG and 0.5% GA were the best preservative which has the nearly same characteristic pH as 0.3% Na2HPO4. The alkaline nature of phosphate used as a preservative in meat products is a means to improve water retention by elevating the pH and ionic strength of meat mixtures **(Choi et al. 2014).** Thus, the pH is an important factor that determines the best replacer of synthetic phosphate in meat products depending on the ability of these alternatives to retain water and subsequently increase the product water holding capacity thus improving the product yield. The increment of high moisture content may be due to GA rich with fiber that hold more water. These agreed with **Choi et al. (2016)** who explained that dietary fiber sources could hold three or four times its weight of water. The obtained results matched with **Bae et al. (2017)** who reported that samples treated with MC showed the lowest moisture content as compared with other treated samples. These variations in moisture content of meat products affected by many factors including the type and amount of additives used, as well as the type of meat products **(Casco et al., 2013).** The maximum permissible level of phosphates in meat and poultry products was 0.5% as determined by **USDA-FSIS (2015),** while it is used by 0.3- 0.4% in meat product industry **(Sebranek, 2009).** Furthermore, the results agreed with **Jeong (2016)** who stated that there was no significance difference ($P>0.05$) between pH of control samples and samples treated with MC.

Many researches showed that high dietary synthetic phosphates intake leads to increasing the risk of kidney and bone diseases, as well as cardiovascular and pulmonary diseases. Therefore, reducing the amount of phosphates in processed food product formulations or replacing them with natural components can serve the same technological effects to improve the functionalities of meat products **(Méndez-Zamora et al. 2015),** functional carbohydrates, including guar gum **(Park et al., 2008)**. 0.2% oyster shell calcium powder and 0.3% eggshell calcium powder (**Jeong et al., 2018).**

Frying conditions (temperature and time), physicochemical characteristics of food (size, shape, cooking loss, pH and initial moisture in the sample, and surface-to-weight ratio), and oil characteristics are factors that influence product **(Asokapandian et al., 2020).** The current results showed that there are a correlation between pH and cooking loss in which the more increase in pH resulted in decrease cooking loss. These losses resulted from evaporation of moisture during the cooking process. Meanwhile, addition of gums forms a firm matrix that prevents migration of moisture from fried food and penetration of fat in it during frying process **(Demirci et al., 2014)**. This matched with **Namir et al. (2015)** who concluded that that the fiber content of GA could influence the cooking loss of beef burger, since fibers could reduce the water loss during cooking by forming gels. **Rather et al. (2016)** reported that GA is rich in fiber which could influence the cooking yield of beef burger, resulting in retention of water during cooking by forming gels. Our results agreed with **Kilincceker and Yilmaz (2016)** who found that addition of GG in a concentration of 0.5, 1 and 1.5% showed better effect on increasing frying yield and moisture retention. **Tabarestani and Tehrani (2014)** reported that GG represented as a hydrocolloid substance that useful for increasing the binding properties of minced beef as well as decrease the water activity of meat products. It was also shown that the treatments containing GG significantly reduce the cooking time and cooking losses due to combining guar with amylose and reducing the solubility of starch granules.

Hamdani et al. (2017) reported that GG had strong antibacterial properties against gram negative bacteria as *E. coli.* Guar gum has antimicrobial properties, and used in a form of edible films coating the products which contains antimicrobial agents that actually prolongs the shelf life of the food and its products **(Kumar et al., 2021).** Our result also agreed with **El-Shinawy and Abdelmonem (2020)** who concluded that GG and MC (0.5% of both) were the best preservatives as they reduced the (APC) level from 4.91±0.01(control) to 4.50±0.02 and 4.48±0.04 in compared to Na2HPO4 (4.7±.0.02). Also consistent with **Alawi et al. (2017**) who used GA against different Gram-positive as well as Gram-negative clinical pathogenic isolates such as *S. aureus and E. coli* strains at concentrations of 2, 1, 0.5, and 0.25 mg/ml and recorded its antimicrobial activity which revealed bacteriostatic effects. In this regard**, Lawrence et al. (2015)** reported that GA had good antibacterial effect especially against *S. aureus, B. subtilis, S. typhi,* and *E. coli.* Moreover**, Marwa and Rania (2020)** reported that GA had an inhibitory effect against both gram-positive and gram-negative. Gram-positive bacteria have more complex cell walls that act as barriers, making them more resistant to antibacterial agents than Gram-negative bacteria, which can hinder the effectiveness of GA extract. The concentration of the GA solution also increases the inhibition zone of *E. coli* and other bacteria. **(AlBehadily et al., 2020).** The antimicrobial activity of GA may be attributed to its content of saponin, glycosides, volatile oils, hydrolysable tannin, triterpenoid, flavonoids, phenol, and alkaloids **(Godghate et al., 2014)**. Moreover, GA contains many types of enzymes such as oxidases, peroxidases, and pectinases which have antimicrobial activities **(Saini et al., 2008).** Also, GG was recommended by EU Regulation No. 257/2010 [mentioned into the EU specifications of guar gum (E 412)] as polysaccharide thickening agents that help in clearance of *E. coli* and reduce total aerobic microbial count as well as total yeasts and molds count from food products.

Sensory properties including appearance, color, odor, texture, and overall acceptability have a major effect on the attractiveness of foods and consumer preference. So, they should be determined in the new product **Kilincceker and Yilmaz (2016).** Sensory evaluations regarding preference and intensity are often conducted with trained panelists to evaluate the inherent qualities of food and ingredients **(Liu et al., 2022)**

In all sensory properties categories, C group received the highest scores in comparison to other groups. But beef burger samples treated with 0.5% GG and 0.5% GA had higher overall acceptability scores for both raw and cooked groups than other treated beef burger samples. Increasing taste scores in cooked samples treated with 0.5% GA and 0.5% GG. Generally, the addition of gum decreased the fat ratio in raw sample. Consequently, reducing the formation of a heavy fatty taste. While the texture profiles of beef burger varied depending on the type and concentration of used natural replacers, the addition of 0.5% either GA or GG highly increase the texture parameters, which were the most closely adjacent to those of Na2HPO4 and C groups respectively, and were associated with high scores from the panelists ($p < 0.05$), indicating that the intensity level of texture was satisfactory, according to the panel's preferences. The texture improved with moisture ration. Increasing moisture content of these samples resulted in the form of juicy and softer structure and increased texture scores. Further, hydrocolloid gums (GG) store water and create a gel network, which enhances their juiciness over time **(Gupta and Variyar, 2018).** It was investigated that whether GG or GA could replace phosphate in processing pork sausages. In addition to increasing WHC, the hydrocolloid compounds also reduced cooking loss and subsequently, increasing cooking yield. However, there was no significant difference in the odor of both control and all treated samples. Similar results were determined by **Yilmaz (2004)**, and **Mansour and Khalil (1997)** as they mentioned that high sensory scores of meat patties prepared by addition of gum. The current results also comply with **Kilincceker and Yilmaz (2016)** who found that addition of different gums improve sensory properties of meat patties. The obtained results are also particularly agreement with those of **Mwove et al. (2016),** who reported that using of GA significantly improve the sensory attributes in cooked beef burger samples. Finally, the addition GA and GG to beef burger could improve overall acceptability including color, odor, taste and texture as same as synthetic additives. During heating process, meat loses its red color at around 65 °C due to the denaturation of myoglobin (**Hunt et al. 1999).**

5. CONCLUSION

From the previous obtained data, it could be concluded that all natural replacers used in the current study could be substitutes the synthetic Na2HPO4, in terms safety issues and quality parameters especially, the use of gums (GG & GA) which can enhance the quality of beef burger during frying by increasing their ability to retain water and subsequently, minimize cooking loss by increasing the pH of the product and eventually, increasing the cooking yield. As a result, the effect of gums on beef burger increased with using 0.5% guar gum and all levels (0.3, and 0.5%) of gum Arabic are suitable alternative to produce good quality beef burger with better sensory acceptability for frying processes, because they have a strong hydrogen bond of gum forming tendency in water that makes them more thickener and stabilizer resulting in improving texture of the final product, high production yield and prolong the product shelf life. Therefore, the addition of these gums and milk calcium with, specified levels in beef burger are more advantageous during manufacturing as natural replacers for synthetic ones.

6. REFERENCES

1. Abdul-Hadi A H, Mahmoud A E, AbdelWahab H M. Effect of gum Arabic on coagulation system of albino rats. Int. J. Pharm. Tech. Res., 2010; 2: 1762-1766.
2. Alawi SM Al, Hossain MA, Abusham AA. Antimicrobial and cytotoxic comparative study of different extracts of Omani and Sudanese gum acacia. *Beni-Suef Univ J Basic Appl Sci.*, 7: 22–6. 10.1016/j.bjbas.2017.10.007 [CrossRef] [Google Scholar].
3. Al-Behadliy N K, Al-Wazni W S, Alwan A H. Evaluation of some biological activities of arabic gum (Sengalia Senegal) aqueous extract in-vivo and in-vitro. In AIP Conference Proceedings (2020 December; Vol. 2290, No. 1, p. 020021). AIP Publishing LLC.
4. Aleson-Carbonell L, Fernandez Lopez J, Perez-Alvaez J A, Kuri V. Characteristics of beef burger as influenced by various types of lemon albedo. Inno. Food Sci. and Emer. Technol., 2005; 6: 247-255.
5. American public health association (APHA). Compendium of Methods for Microbiological Examination of Food, 2001.
6. AOAC. Official methods of analysis (17th ed.). Association of Official Analytical Chemists, Washington, 2002.
7. Asokapandian S, Swamy G J, Hajjul H. Deep fat frying of foods: A critical review of process and product parameters. Crit Rev Food Sci Nutr, 2020; 60(20): 3400-3413. doi: 10.1080/ 10408398.1688761.
8. Bae S M, Cho M G, Jeong J Y. Effects of Various Calcium Powders as Replacers for Synthetic Phosphate on the Quality Properties of Ground Pork Meat Products. Korean J. for Food Korean J. Food Sci. An, 2017; 37(3): 456-463.
9. Casco G, Veluz GA, Alvarado C Z. (2013).SavorPhos as an All-Natural Phosphate Replacer in Water- and Oil-Based Marinades for Rotisserie Birds and Boneless-Skinless Breast. Poult. Sci, 2013; 92: 3236–3243. [CrossRef] [PubMed].
10. Cho M G, Bae S M, Jeong J Y. Egg shell and oyster shell powder as alternatives for synthetic phosphate: Effects on the quality of cooked ground pork products. Korean J. Food Sci. An., 2017; 37: 571–578.
11. Choi Y, Sung J, Park J, Lee H C, Jeon T K, Kim C J,Kim Y. Quality and sensory characteristics of reduced-fat chicken patties with pork back fat replaced by dietary fiber from wheat sprout. Korean Journal for Food Science of Animal Resources, 2016; 36: 799-806.
12. Choi J S, Lee H J, Jin S K, Lee H J, Choi Y I. Effect of oyster shell calcium powder on the quality

of restructured pork ham. Korean J. Food Sci. An., 2014; 34: 372– 377.
13. Dehghani Soltani M, Meftahizadeh H, Barani M, Rahdar A, Hosseinikhah S M, Hatami M, Ghorbanpour M. Guar (*Cyamopsis tetragonoloba* L.) plant gum: From biological applications to advanced nanomedicine. *International Journal of Biological Macromolecules,* 2021; 193: 1972–1985. [PubMed] [Google Scholar.
14. Demirci Z O, Yilmaz I, Demirci A.S. Effects of xanthan, guar, carrageenan and locust bean gum addition on physical, chemical and sensory properties of meatballs. Journal of food Science and Technology, 2014; 51(1): 936-942.
15. El-Shinawy Noha M, Abdelmonem Mohamed A. Trials for replacing industrial phosphate salts with milk calcium and guar gum powders as a natural product to improve the quality of minced beef Animal Health Research Journal, 2020; 8(2): 15-25. ISSN: 2356-7767.
16. Fiorentini M, Kinchla A J, Nolden A A. Role of sensory evaluation in consumer acceptance of plant-based meat analogs and meat extenders: A scoping review. *Foods*, 2020; *9*: 1334. [Google Scholar] [CrossRef] [PubMed].
17. Food and Drug Administration "FDA". S. *aureus*. Bacteriological analytical manual. 8th Ed. Chapter12, 2001; Academic Press, Gaithersburg, UK.
18. Godghate A G, Sawant R S, Sankpal S A, Walaki S A, Kankanwadi S S. Phytochemical analysis of bark of Acacia nilotica. Asian Journal of Plant Science Research, 2014; 4(2): 22–24.
19. Gupta S, Variyar PS. Biopolymers for Food Design, Handbook of Food Bioengineering, Chapter 12-, Guar gum, a versatile Polymer for the Food Industry, 2018; 383-407.
20. Hamdani A M, Wani I A, Bhat N A , Siddiqi R A. Effect of guar gum conjugation on functional, antioxidant and antimicrobial activity of egg white lysozyme. Food Chem. J., 2017; 240.1201-1209.
21. Hashem Alyaa M A, Youssef K M E, Mostafa M D, Magda A A Seliem. The influence of frozen storage on physical and organoleptic properties of beef and low-fat beef burgers. Assiut J. of Agric. Sci., 2011; 42 (Special Issue) (The 5th Conference of Young Scientists Fac. of Agric. Assiut Univ. 8: 184-211.
22. Hunt M, Sørheim O, Slinde E. Color and heat denaturation of myoglobin forms in ground beef. *J. Food Sci*, 1999; 64: 847–851. doi: 10.1111/j.1365-2621.1999.tb15925.x. [CrossRef] [Google Scholar].
23. International Organization for Standardization. Microbiology of the Food Chain—Horizontal Method for the Enumeration of Microorganisms—Part 2: Colony Count at 30 °C by the Surface Plating Technique (ISO 833-2:2013). Available online: https ://www.isoorg/ standard/59509.html.
24. International Organization for Standardization. Microbiology of the Food Chain—Horizontal Method for the Enumeration of Beta-Glucuronidase-Positive Escherichia Coli—Part 1: Colony-Count Technique at 44 °C Using Membranes and 5-Bromo-4-Chloro-3-Indolyl Beta-D-Glucuronide (ISO 16649-1:2018). Available online: https://www.iso.org/standard/64951.html.
25. Jeong J Y. Alternative curing technology in meat products. Food Sci. Anim. Resour. Ind., 2016; 5: 77–84.
26. Jeong J Y. Determining the optimal level of natural calcium powders and whey protein concentrate blends as phosphate replacers in cooked ground pork products Korean J. Food Sci. Anim. Res., 2018; 38(6): 1246−52.
27. Kausar T, Hanan E, Ayob O, Praween B, Azad Z. A review on functional ingredients in red meat products. *Bioinformation,* 2019; 15: 358–63. 10.6026/97320630015358 [PMC free article] [PubMed.
28. Khalifa A M. Physico-chemical, Microbiological and Organolyptic Characteristics of Beef burger as Affected by Addition of Potato Peel and Orange Albedo. Ph.D. 2011; Thesis. Food Sci. Technol. Dept., Fac. Agric., Tanta Univ
29. Kilincceker O, Dogan I S, Kucukoner E. Effect of edible coatings on the quality of frozen fish fillets. LWT- Food Science and Technology, 2009; 42(4): 868-873.
30. Kilincceker O, Yilmaz MT. Effect of different gums on some properties of fried beef patties. Food Science and Technology J., 2016; 8(2): 63-70.
31. Kim T K, Ku S K, Kim Y B, Jeon K H and Choi Y S. Substitution and technology trend of synthetic additives in processed meat industry: Nitrite and phosphate. Food Sci Anim. Resour Ind., 2017; 6: 98– 108.
32. Kumar L, Ramakanth D, Akhila K, Gaikwad K K. Edible films and coatings for food packaging applications: A revie. Environmental Chemistry Letters, 2021; 20: 1–26. [Google Scholar].
33. Lawrence R, Jeyakumar E,, Gupta A. Antibacterial activity of Acacia arabica (Bark) extract against selected multi drug resistant pathogenic Bacteria. International Journal of Current Microbiology and Applied Sciences, 2015; 1, Special Issue-1: 213–222.
34. Liu Q, Wang S, Wang X, Dong S, Zhao Y, Zeng M. The relationship between the formation of advanced glycation end products and quality attributes of fried sturgeon fillets. *LWT*, 2022; *159*: 113161. [Google Scholar] [CrossRef]
35. Lopes B M, Lessa V L, Silva B M, Filho M A, Schnitzler E, Lacerda L G. Xanthan gum properties, production conditions, quality and economicperspective. Journal of Food and Nutrition Research, 2015; 54(3): 185-194.
36. Mansour E H, Khalil A H. Characteristics of low-fat beef burger as influenced by various types of wheat fibers. Food Research International, 1997; 30: 199-205.

37. Mariana A M, María L B, Lorena V, Claudio D B. Gum Arabic: More than an edible emulsifier. Products Applic. Biopolymers. 2012; DOI: 10.5772/33783
38. Marwa R. Ali and| Rania M. EL Said. Assessment of the potential of Arabic gum as an antimicrobial and antioxidant agent in developing vegan "egg-free" mayonnaise. J Food Saf, 2020; https: //doi. org/10. 1111/ jfs.12771
39. Méndez-Zamora G, García-Macías J A, Santellano-Estrada E, Chávez-Martínez A, DuránMeléndez L A, Silva-Vázquez R, Quintero-Ramos A. Fat reduction in the formulation of frankfurter sausages using inulin and pectin Food Science and Technology (Campinas), 2015; 35(1): 25–31.
40. Mwove J K, L A Gogo, B N Chikamai,M N Omwamba,S M Mahungu. Preparation and quality evaluation of extended beef rounds containing gum Arabic from Acacia Senegal var. kerensis. Food and Nutrition Sciences, 2016; 7(11): 977.
41. Namir M, H Siliha, M F Ramadan. Fiber pectin from tomato pomace: characteristics, functional properties and application in low-fat beef burger. Journal of Food Measurement and Characterization, 2015; 9(3): 305–312.
42. Park K S, Choi Y I, Lee S H, Kim Ch H, Auh J H. Application of functional carbohydrates as a substitute for inorganic polyphosphate in pork meat processing Korean J. Food Sci. Tech, 2008; 40(1): 118−21.
43. Pelin-Can O, Arslan A. Determination of shelf life of marinated carp fillets. Biotechnology in Animal Husbandry, 2011; 27(1): 101-11.
44. Pourfarzad A, Yousefi A. Effect of different excipients on physicochemical properties of the functional rice bran tablet: Univariate and multivariate studies on a novel food supplement. Journal of Food Measurement and Characterization, 2020; 15: 1359–1369.
45. Rather S A, Masoodi F A, Akhter R, Gani A, Wani S M, Malik A H. Effects of guar gum as fat replacer on some quality parameters of mutton goshtaba, a traditional Indian meat product. Small Ruminant Research, 2016; 137: 169–176.
46. Reddy T T, Tammishetti S. Free radical degradation of guar gum. J. Polymer Degradation and Stability, 2006; 86(3): 455- 459.
47. Saini M, Saini R, Roy S, Kumar A. Comparative pharmacognostical and antimicrobial studies of Acacia species (Mimosaceae). Journal of Medical. Plant Research, 2008; 2(12): 378–386. https://doi.org/10. 12691/bb-1-2-3.
48. Sebranek J G. Basic curing ingredients In: Tarte R., editor. Ingredients in meat products. Springer Science Business Media LLC; NY., 2009; 1–24.
49. Sebranek J G. An overview of functional non-meat ingredients in meat processing: The current toolbox; Annual Reciprocal Meat Conference; Lincoln, NE, USA, pp. 2015; 42–46.
50. Sindelar J J. Impact of removing functional non-meat ingredients in processed meat products and exploring possible alternatives; Proceed. 68th Recip. Meat Conf.; Lin-coln, NE, USA, pp. 2015; 48–51.
51. Srichamroen A. Influence of Temperature and Salt on Viscosity Property of Guar Gum, Naresuan University J., 2007; 15(2): 55-62.
52. Tabarestani H S, Tehrani M M. Optimization of physicochemical properties of low-fat hamburger formulation using blend of soy flour, split pea flour and wheat starch as part of fat replacer system. Food. Processing and Preservation J., 2014; 38(1): 278- 288.
53. USDA-FSIS. Safe and suitable ingredients used in the production of meat, poultry, and egg products. FSIS Directive 7120.1 Rev.31. United States Department of Agriculture. Food Safety and Inspection Service; Washington, 2015; DC, USA: 2015.
54. US-FDA. Code of Federal Regulations (SFR) Chapter 1- Food and Drug Administration. Department of Health and Human Services. Subchapter B. Food for human consumption, 2019; Title 21. Vol.3.
55. Whitton C, Bogueva D, Marinova D, Phillips C J.Are we approaching peak meat consumption? Analysis of meat consumption from 2000 to 2019 in 35 countries and its relationship to gross domestic product. *Animals*, 2021; *11:* 3466. [Google Scholar] [CrossRef] [PubMed]
56. Yilmaz I. Effects of rye bran addition on fatty acid composition and quality characteristics of low-fat meatballs. Meat Science, 2004; 67(2): 245-249.