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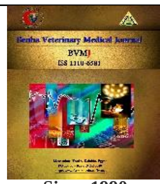

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Original Paper

Public health hazards of some preservatives in meat products

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ABSTRACT

Meat products are high in nutrients, so this study provides the chemical determination of certain preservatives in meat products, such as ascorbic acid (ppm), monosodium glutamate (ppm), phosphate (%), and sodium chloride (%). A total of 100 randomly selected samples of locally made meat were obtained from various marketplaces in Egypt. The beef burger, kofta, and sausage samples were frozen and weighed 340 g apiece, whilst the luncheon samples were gathered as slices (250 g). Each sample was stored in a separate sterile polyethylene bag in an ice box before being carried directly to the laboratory. The mean values of ascorbic acid (ppm), monosodium glutamate (ppm), phosphate (%), and sodium chloride (%) were 221.4 ± 7.1; 2.77 ± 0.25; 0.15 ± 0.09; and 3.17 ± 0.15 in the examined beef burger, respectively; 191.5 ± 20.3, 1.75 ±.75, 0.09 ± 0.03; and 3.12 ± 1.32 in the examined beef kofta; respectively; 294.3 ± 19.8, 3.74 ± 0.30, 0.21 ± 0.11; and 5.91 ± 0.27 in the examined beef luncheon; respectively; and 245. 9 ± 7.6, 2.38 ± 0.92; 0.19 ± 0.2; and 2.40 ± 0.33 in the examined beef sausage, respectively. According to E.S. (2005), the current investigation also identified non-acceptable meat products exposed to unlawful quantities of ascorbic acid, monosodium glutamate, phosphate, and sodium chloride.

1. INTRODUCTION

Meat products are popular because they offer quick, easy-to-prepare meat dinners and alleviate the problem of a scarcity of fresh meat at high prices. Although meat products can be sourced as raw materials from a source with minimal microbial contamination, they may get infected throughout the manufacturing process (Younes et al., 2019). Because of their high-water activity and nutritional content, meat products are vulnerable to contamination by food-borne diseases and different spoilage bacteria. As a result, preservatives are an essential component in the animal food sector for delaying rotting, preventing food poisoning, and extending shelf life. Consumers of food do not prefer industrial preservatives due to their detrimental effects on health (Yu et al., 2021).

Preservatives are defined as constituents that can extend the shelf-life of different foods by protecting them against spoilage by microorganisms. Meat, owing to its high content of nutritional ingredients, high water activity, and pH = 5.5–6.5, is a suitable environment for the growth of microbes, mainly bacteria (Efenberger-Szmechtyk et al., 2021). Chemical preservatives are consequently of great importance in the meat industry. They can extend the shelf life of meat products through inhibition of spoilage and pathogenic bacteria, decrease the oxidation of meat product ingredients, and improve their organoleptic characteristics (Nikmaram et al., 2018). A shift towards more natural ingredients has occurred in the food industry as a result of growing concerns about the safety of synthetic substances used in food (Singh et al., 2015). Specifically, the 'clean label' food trends, which included meat and meat products, originated in the UK in the 1990s and were a key source of marketing food. It has consumer-friendly features such as no synthetic additives, little processing, a short list of food components, and the use of traditional methods (Asioli et al., 2017).

Not all food preservatives are harmful, especially if they are manufactured under controlled conditions and used in food items in amounts permitted by food laws (Nayel, 2013). The claims that declare the absence or presence of food additives in the labeling, for example, 'without artificial colors' and 'without preservatives', lead the consumer to trust that the product is safe and has higher quality when they do not present any relation with health benefits (National Health Surveillance Agency; Anvisa, 2017). The most often used food additive is ascorbic acid, which is also known as vitamin C but cannot be classified as vitamin C. Chemically synthesized, nature-identical L-ascorbic acid is used in the food sector (Lee et al., 2018). Ascorbic acid is a common antioxidant found in processed meats. Many researchers agree that ascorbic acid is soluble in water and has no hazardous effects on humans

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(Varvara et al., 2016). Because it oxidizes to dehydroascorbic acid in oxygen, ascorbic acid is an antioxidant. Its antioxidant properties inhibit metamyoglobin formation and oxidation, which discolors meat during storage; enhances meat color and shelf life (Mahmoud and Abu-Salem, 2015) .

Monosodium glutamate is often used as a flavor enhancer in the food industry, and its usage is on the rise, prompting worries about potential side effects (Moldovan et al., 2021). The FDA declared monosodium glutamate safe for limited usage while noting certain potential negative effects associated with increased MSG consumption. Circulatory, cardiac, muscular, gastrointestinal, and neurological issues are becoming increasingly common (Kazmi et al., 2017). As a result, MSG would be directly responsible for genetic harm. It may modify the genetic material, causing free radicals to cause harm by destroying the nuclear component of the cell (Imam, 2019).

Phosphate improves the technological properties of meat products, but higher levels can lead to technological defects such as a rubbery taste and a soapy texture on meat products, in addition to adverse effects on human health, so phosphate use is regulated by law, setting the maximum allowable level of it in a meat product (Dimitrovska et al., 2019).

Sodium chloride salt changes the activity of muscle enzymes and the solubilization of myofibrillar proteins, which makes the texture of meat better. (Bombrum et al., 2014). Because salt has been linked to negative health consequences, WHO advises a daily sodium chloride consumption of less than 5 g for adults (Kloss et al., 2015). Sodium chloride consumption varies among people and populations around the world, although it is often greater than the recommended amount. High salt consumption in the diet was linked to high blood pressure, which can lead to stroke and heart attack (Khalafalla et al., 2022).

Despite the fact that the previously described chemical preservatives serve important purposes in further processed meat products, uncontrolled excessive quantities might cause technological faults or pose public health risks. As a result, the present work was designed to compare the levels of ascorbic acid, monosodium glutamate, phosphate, and sodium chloride in beef burgers, Kofta, luncheons, and sausages sold in Benha City, Kalyobia Governorate, Egypt, to national and international standards.

2. MATERIAL AND METHODS

One hundred random samples of locally made meat items (beef burger, kofta, luncheon, and sausage) (25 of each) were obtained from different marketplaces in Benha city, Kalyobia governorate, Egypt, at various times. The beef burger, kofta, and sausage samples were frozen and weighed 340 g apiece, but the luncheon samples were gathered as slices (250 g). Each sample was maintained in a separate plastic bag and stored in an ice box before being transferred to the Animal Health Research Institute. The obtained samples were chemically examined for ascorbic acid, monosodium glutamate, phosphate, and sodium chloride levels.

This study was approved by The Ethics Committee of the Faculty of Veterinary Medicine, Benha University (Ethical Approval Number: BUFVTM 31-09-23)

2.2 .Determination of chemical preservatives

2.2.1 .Estimation of ascorbic acid (AOAC, 2016)

Preparation of test sample solution for estimation of ascorbic acid **(AOAC, 2016)** by mixing twenty grams of the examined sample with 85 ml dist. water and let stand for 10 minutes. Aqueous solution was filtrated through a funnel containing glass wool into second beaker, then Accurately, 0.4 ml CH_3COOH-HPO_3 solution was mixed with 25 ml of filtered solution, plus 2 ml of indophenol solution. There is no additional ascorbic acid present if the solution turns purple-pink and stays that way for 10 seconds. If the dye did not remain coloured (the solution remained grey), indophenol solution was added from the burette in 0.5 ml increments to the purple-pink end point, which was stable for 10 seconds. Ascorbic acid was calculated as follow:

Ascorbic acid mg /100 g = (V E) (100 mL/25 ml) (100/W).

Where, V = ml indophenol solution, E = mg ascorbic acid/mL indophenol standard solution, W = weight test portion (20 g).

2.2.2 Determination of MSG in meat samples *according to (Lateef et al. 2012).*

By using HPLC (Agilent Series 1050 quaternary gradient pump, Series 1050 auto sampler, Series 1050 UV Vis detector, and HPLC 2D Chemstation software (Hewlett-Packard, Les Ulis, France).

2.2.3 .Estimation of phosphate content (AOAC, 2016)

Ten ml of nitric acid was mixed with the ash content of the examined sample and heated in a bath of boiling water for 30 minutes, complete to 100 ml with dist. water after cooling then filtrated. Further, 20 ml of clear and colorless filtrate were transferred and mixed with 30 ml coloring reagent then completed to 100 ml with distilled water and let stand for 15 minutes in a dark place. concentration of Phosphate was calculated spectrophotometrically at wave length of 430 nm. Total phosphate was calculated according to the following formula:-

Total phosphorus pentoxide = A/(M x 20), Where A=concentration of phosphorus pentoxide in sample as a reading from standard curve(μg /ml). While, M= weight of sample (gram). Natural phosphorus in meat= protein % x 250\10000 (μg/g). Added phosphate = Total phosphate - Natural phosphate.

2.2.4 Estimation of sodium chloride percentage (AOAC, 2016)

To 1 gram of the sample, 40 ml of Silver nitrate solution N/10 were added to precipitate all the chloride as Silver chloride, then 5 ml nitric acid was added. The contents were then gently boiled on hot plate until all solids except Silver chloride were dissolved (about 15 minutes). After cooling, 50 ml of distilled water and 2 ml of saturated solution of ferric

Ammonium sulphate were added. The excess of silver nitrate was titrated against N/10 Ammonium thiocynate solution using ferric indicator. The amount of standard Ammonium thiocyanate exhausted in the titration (R) was recorded. The same technique was repeated using 0.5 ml of the brine solution. The Sodium chloride % was calculated according to the following formula.

Sodium chloride % = (R -10 × 0.00585 × 10)

Where, R= ml of exhausted 0.1N silver nitrate.

2.3 .Statistical analysis

Analysis performed using graph pad prism version 8: one-way ANOVA using Dunnett's multiple comparisons test with individual variances (p < 0.05) computed for each comparison mean value ± SD.

3. RESULTS

The mean values of ascorbic acid (ppm) were 221.4 ± 7.1 for beef burgers, 191.5 ± 20.3 for beef kofta, 294.3 ± 19.8 for beef luncheons, and 245.9 ± 7.6 for beef sausages (table 1). On the other hand, the results obtained in Table 2 showed that 4 samples (16%) of beef burgers, 2 samples (8%) of beef kofta, 7 samples (28%) of beef luncheons, and 5 samples (20%) of beef sausage contain ascorbic acid and are not prescribed on the label of these samples. Also, table (2) showed that 8 (32%), 5 (20%), 11 (44%), and 4(16%) of beef burger, kofta, luncheon, and sausage samples exceeded the permissible limits (500 ppm) for ascorbic acid contents recommended by E.S. (2005). Table 3 showed that the mean values of monosodium glutamate (ppm) were 2.77 ± 0.25 for beef burgers, 1.75 ± 0.75 for beef kofta, 3.74 ± 0.30 for beef luncheons, and 2.38 ± 0.92 for beef sausages. Also, table (4) revealed that 7 samples (28%) of beef burger, 3 samples (12%) of beef kofta, 9 samples (36%) of beef luncheon, and 5 samples (20%) of sausage contain MSG not prescribed on the label of these samples. As well, results in Table 4 showed that 3 (12%), 6 (24%), and 5 (20%) of beef burger, kofta, luncheon, and sausage samples exceeded the permissible limits (≤ 5000 ppm) for monosodium glutamate contents recommended by E.S. (2005). Moreover, table 5 showed that the mean values of phosphate (%) in the examined meat product samples were 0.15 ± 0.09 for beef burgers, 0.09 ± 0.03 for beef koftas, 0.21 ± 0.11 for beef luncheons, and 0.19 ± 0.2 for beef sausages. As well, table (6) revealed that 3 samples (12%) of beef burger, 1 sample (4%) of beef kofta, 5 samples (20%) of beef luncheon, and 4 samples (16%) of beef sausage contain phosphate and are not prescribed on the label of these samples. Also, Table 6 shows that the phosphate levels in 15 (60%), 10 (40%), 13 (52%), and 17 (68%) of the beef burger, kofta, luncheon, and sausage samples were higher than the 0.3% limit set by E.S. (2005).

Concerning the results obtained in Table 7, it was indicated that the mean values of sodium chloride% in the examined meat product samples were 3.17 ± 0.15 for beef burgers, 3.12 ± 1.32 for beef kofta, 5.91 ± 0.27 for beef luncheons, and 2.40 ± 0.33 for beef sausages. Also, table (8) showed that 6 samples (24%) of beef burger, 4 samples (16%) of beef kofta, 8 samples (32%) of beef luncheon, and 3 samples 12%) of beef sausage contain sodium chloride and are not prescribed on the label of these samples. Moreover, data in Table 8 showed that 16 (64%), 11 (44%), 14 (56%), and 9 (36%) of beef burger, kofta, luncheon, and sausage samples exceeded the permissible limits for sodium chloride contents recommended by E.S. (2005).

Table (1) Statistical analyses of ascorbic acid values (ppm) of different examined meat products samples (n = 25 of each)

Meat products	Min. (ppm)	Max. (ppm)	Mean ± SD (ppm)
Burger	210	232	221.4 ± 7.1^{c}
Kofta	165	227	191.5 ± 20.3^{a}
Luncheon	263	325	294.3 ± 19.8^{b}
Sausage	235	259	245.9 ± 7.6^{d}

Different small superscripted letter is significantly different at $P < 0.05$

Table (2) Incidence of ascorbic acid contents of different examined meat products (n= 25 of each)

Meat products	Un acceptable samples		Non prescribed on label		Permissible limit acc. to E.S(2005)
	No.	%	No.	%	
burger	8	32	4	16	500 ppm
Kofta	5	20	2	8	500 ppm
Luncheon	11	44	7	28	500 ppm
Sausage	4	16	5	20	500 ppm

Table (3) Statistical analyses of MSG values (mg/gm) of different examined meat products samples (n = 25 of each)

Meat products	Min. (mg/gm)	Max. (mg/gm)	Mean ± SD (mg/gm)
burger	2.4	3.2	2.77 ± 0.25^{c}
Kofta	0.8	2.8	1.75 ± 0.75^{a}
luncheon	3.2	4.1	3.74 ± 0.30^{b}
Sausage	1.1	3.9	2.38 ± 0.92^{c}

Different small superscripted letter is significantly different at $p < 0.05$

Table (4) Incidence of monosodium glutamate values of different examined meat products (n = 25 of each)

Meat products	Un acceptable samples		Non prescribed on label		Permissible limit acc. to E.S(2005)
	No.	%	No.	%	
burger	3	12	7	28	≤ 5000 ppm
Kofta	3	12	3	12	≤ 5000 ppm
Luncheon	6	24	9	36	≤ 5000 ppm
Sausage	5	20	5	20	≤ 5000 ppm

Table (5) Statistical analyses of phosphates values (%) of different examined meat products samples (n = 25 of each)

Meat products	Min. (%)	Max. (%)	Mean ± SD (%)
burger	0.08	0.45	0.15 ± 0.09^{c}
Kofta	0.04	0.29	0.09 ± 0.03^{a}
luncheon	0.09	0.55	0.21 ± 0.11^{b}
Sausage	0.07	0.50	0.19 ± 0.2^{c}

Different small superscripted letter is significantly different at $p < 0.05$

Table (6) Incidence of phosphates contents (%) on labels of different examined meat products (n = 25 of each)

Meat products	Un acceptable samples		Non prescribed on label		Permissible limit acc. to E.S(2005)
	No.	%	No.	%	
burger	15	60	3	12	0.3%
Kofta	10	40	1	4	0.3%
Luncheon	13	52	5	20	0.3%
Sausage	17	68	4	16	0.3%

Table (7) Statistical analyses of sodium chloride values (%) of different examined meat products samples (n = 25 of each)

Meat products	Min. (%)	Max. (%)	Mean ± SD (%)
Burger	2.8	3.6	3.17 ± 0.15^{c}
Kofta	1.4	5.5	3.12 ± 1.32^{a}
Luncheon	5.4	6.3	5.91 ± 0.27^{b}
Sausage	1.9	2.9	2.40 ± 0.33^{d}

Different small superscripted letter is significantly different at $P < 0.05$

Table (8) Incidence of sodium chloride (%) on labels of different examined meat products (n = 25 of each)

Meat products	un acceptable samples		Non prescribed on label		Permissible limit acc. to E.S(2005)
	No.	%	No.	%	
burger	16	64	6	24	2%
Kofta	11	44	4	16	3%
Luncheon	14	56	8	32	3%
Sausage	9	36	3	12	3%

4. DISCUSSION

Chemical additions are required for the production of meat products; however greater quantities than permitted may pose a public health risk and/or technological issues (Khalafalla et al., 2022). In terms of ascorbic acid data, beef luncheon had the highest concentration mean value, followed by beef sausage, beef burger, and beef kofta, which had the lowest. In comparison to earlier studies by Nayel (2013) which showed greater results: 487.82 ± 22.84 for beef burger, 461.29 ± 15.78 for beef kofta, 435.3 ± 36.91 for beef luncheon, and 417.67 ± 20.08 for beef sausage. Concerning the percentage of samples that had ascorbic acid that wasn't listed on the label, Nayel (2013) reported lower results because ascorbic acid was found in all of the beef burgers and sausages that were tested. However, the percentages for beef kofta (4 samples, 20%) and beef luncheon (9 samples, 45%) were higher than what was found. Table (2) further showed that the ascorbic acid levels in the beef burger, kofta, luncheon, and sausage samples were 8 (32%), 5 (20%), 11 (44%), and 4 (16%) times higher than what E.S. (2005) had indicated as acceptable limits. Ascorbic acid is ready to lose a hydrogen atom and transform into dehydroascorbic acid, which has antioxidant properties. Ascorbic acid can be used as a reducing agent in meat products to prevent oxidation and improve color (Gadekar et al., 2014).

Beef luncheon had the highest recorded monosodium glutamate concentration mean values for the analyzed samples, followed by beef burger, beef sausage, and beef kofta, which had the lowest. Compared to prior studies, Ayad et al. (2022) reported 2.75 ± 1.05 for beef bangers and reported greater findings. Ayad et al. (2022), on the other hand, showed lower results: 1.73 ± 0.22 for beef burger and 1.47 ± 0.85 for beef kofta. Concerning the percentage of samples containing MSG and not prescribed on the label, Ayad et al. (2022) found that all beef burgers, kofta, and sausage analyzed were prescribed. According to the FDA, MSG must be specified on the product package label (Moldovan et al., 2021). According to E.S. (2005), all of the beef burger, kofta, luncheon, and sausage samples tested positive for monosodium glutamate. Because monosodium glutamate is a contentious drug in terms of its harmful consequences after lengthy periods of consumption, the FDA requires it to be included on the product package label (Moldovan et al., 2021). The concentration of monosodium glutamate in each product varies; some have not been adjusted in terms of flavor, and the optimal concentration for its impact differs across people (Wijayasekara and Wansapala, 2017).

According to the results of the analysis of the samples, beef luncheon, beef sausage, beef burger, and beef kofta had the highest concentrations of phosphate. In comparison to previous research, Hassan et al. (2018) reported higher results of 0.13±0.01 for beef kofta and 0.21 ± 0.01 for beef burger, but Nayel (2013) reported 0.41 ± 0.02 for the examined beef luncheon and 0.43 ± 0.019 for the examined beef sausage samples. Phosphate identified in all examined beef kofta, burgers, and sausages investigated by Hassan et al. (2018) was prescribed. Table (6) also revealed that 15 (60%), 10 (40%), 13 (52%), and 17 (68%), respectively, of the beef burger, kofta, luncheon, and sausage samples were above the allowable phosphate levels (0.3%) specified by E.S. (2005). Many studies have examined the phosphorus content in meat products. In this regard, Dimitrovska et al. (2019) discovered that around 64% of raw beef and pork products in the north Macedonian market exceeded 5000 ppm (0.5%). Also, Koricanac et al. (2015) evaluated phosphates in 701 different cooked sausage samples in Serbia and discovered that the most common range (33.38%) was 4.01–5 g/kg.

Beef luncheon had the highest sodium chloride concentration mean value of the examined samples, followed by beef burger, beef kofta, and beef sausage, which had the lowest. When compared to earlier studies, Saad et al. (2018) reported lower results at 1.91 ± 0.28 for beef burger, 2.89 ± 0.41 for beef kofta, and 3.30 ± 0.39 for beef luncheon, while Nayel (2013) reported higher results at 2.93 ± 0.17 for beef sausage, Khalafalla et al. (2022) at 3.95 ± 0.21 for beef sausage, and 4.21 ± 0.08 for beef burger. In terms of the proportion of samples containing sodium chloride and not prescribed on the label, all beef burgers, kofta, and sausages analyzed by Nayel (2013) were prescribed, whereas 9 samples (45%) of beef luncheon were not. Table (8) also revealed that 16 (64%), 11 (44%), 14 (56%), and 9 (36%), respectively, of the beef burger, kofta, luncheon, and sausage samples were above the allowable phosphate levels specified by E.S. (2005). Some beef products have higher levels of residual sodium chloride than allowed, posing a risk to human health (Saad et al., 2018). Salt, on the other hand, is a pro-oxidant that increases rancidity. Furthermore, greater daily sodium chloride salt consumption is linked to high blood pressure and cardiac diseases (Aburto et al., 2013). For meat products, more monitoring, examination, and stringent sanitary measures, as well as good industrial practices (GMP), must be used, especially when food additives are required (Saad et al., 2018).

5. CONCLUSIONS

The acquired data showed that some of the meat products contain more than the allowable levels of chemical preservatives, which has an unfavorable effect on human public health. As a result, Egyptian meat products should be examined for high levels of chemical preservatives. As a result, consumers should read the labels on meat products, and the labels should show the true composition of the product. Preservatives should be used in line with good manufacturing practice (GMP), be of food grade, manufactured, and handled as a food component. The amount applied to meat products should be sufficient to achieve the desired results.

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