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Original Research

Compatibility of Some Commercial Meat Products with the Egyptian Standards Regarding Chemical Additives

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Abstract

Chemical additives were found to be the most widely used and least expensive flavouring and preservatives for meat products, but they must be used within safe-permissible levels to protect customers from any negative effects. With reference to the most recent updates of the Egyptian standards, this study examines the levels of nitrite, phosphate, ascorbic acid, and monosodium glutamate as examples of chemical additives in one hundred and sixty random samples of raw minced meat, beef burgers, sausages, and frankfurters (40 of each), which were collected from different supermarkets located in Shibin Elkom city, Menoufia governorate, Egypt. While nitrite was not found in the minced meat samples, out of the analyzed samples, 92.5%, 97.5, and 100% of the tested sausage, burger, and frankfurter samples, respectively, were within the permitted limits (PL) (≤ 100 ppm) regarding their nitrite level. Furthermore, when it came to ascorbic acid PL (≤ 500 ppm), 72.5%, 100%, 87.5%, and 100% of the minced beef, sausage, burger, and frankfurter samples were within PL, respectively. Additionally, 100%, 90%, 95.0%, and 97.5% of the analyzed minced beef, sausage, burger, and frankfurter samples fell below the acceptable range for monosodium glutamate level (≤ 5000 ppm), respectively. Furthermore, the tested minced beef and sausage samples had no phosphate, whereas 72.5% of the investigated frankfurter samples were within the PL, and all of the studied burger samples were outside the PL (≤ 0.3%). So, it is advised to continuously monitor the meat production market and carefully enforce the safety requirements.

KEYWORDS
Chemical additives, Egyptian standards, Meat products, Nitrite.

INTRODUCTION

Meat and meat products are among the most widely consumed protein sources. It is widely consumed because of its great taste, aroma, juiciness, palatability, and capacity to offer significant biological benefits to human nutrition, according to Suleman *et al.* (2020). Various meat products can be combined with other components to produce goods manufactured from fabricated meat. Meat-based products are incredibly rich in vitamins, minerals, essential amino acids, and trace elements. Meat products' nutritional value often varies based on the meat cuts, cooking methods and food additives (Hathwar *et al.*, 2012).

Due to advantages like ease of preparation, less demand for meat trimmings, and various shapes of product with improved tenderness, juiciness, and flavour characteristics at an affordable price, restructured meat products have emerged as an important type of meat industry as a result of the current economic conditions (Gadekar *et al.*, 2015). Restructured meat products are any meat products that have been partially or entirely dismantled and then reshaped into the same or different forms (Varalakshmi, 2015).

End products that are safe and of high quality are produced by using high-grade raw materials (meat) and additives. As a result, processing low-quality components results in low-quality beef products. The global rise of foodborne infections makes the problem of food preservation increasingly critical. Due to their cheaper prices, simplicity of incorporation into goods, relatively low toxicity when used in the proper dosages, guaranteed antibacterial activity or shelf-life prolonging action, and with minimal impact on flavour, colour, and texture, chemical additives are slowly becoming more prevalent in the food industry (Yu *et al.*, 2021).

The most popular curing agent in meat products is a combination of nitrates and nitrites. Nitrites, which have antioxidant and antibacterial qualities, give cured meat its red color and flavor (Honikel, 2008). The toxigenic Clostridium botulinum and Staphylococcus aureus, which would grow in different meat products under microaerophilic conditions, are prevented from growing by these well-known antimicrobial substances (Lövenklev *et al.*, 2004; Sindelar and Houser, 2009). However, the use of nitrite in food is clouded by concerns that it may react with amines in stomach acid and produce carcinogenic nitrosamines, which would result in the development of numerous malignancies (Archer, 2002).

Ascorbic acid is used to speed up the curing of meat because it slows the reduction of nitrites to nitric oxide. In addition, ascor-

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bic acid reduces the residual level of nitrite far more quickly and effectively than a number of other antioxidants (Li *et al*., 2013).

Phosphates are utilized in the manufacturing of beef products, which increases the emulsion's stability and water retention capacity. In addition to providing customers with critical minerals for their daily requirment, phosphates also stabilize color, prevent lipid oxidation and aid in protein dispersion (Goemaere *et al*., 2021). Phosphorus is a crucial element since it aids in the formation of bones and nucleic acids (Cupisti and Kalantar-Zadeh, 2013). On the other hand, processed meat's high phosphorus content can severely impair its safety.

Glutamic acid, usually referred to as monosodium glutamate (MSG), is a non-essential amino acid that is added to food all over the globe to improve flavor. It is one of the food additives that is most frequently used in processed foods. While it is thought to be linked to a variety of health issues, including obesity, metabolic abnormalities, neurotoxic effects, and harm to the reproductive organs (Kumar *et al*., 2020).

Therefore, the current investigation aimed to identify the concentrations of some processed meat chemical additives in some commercial meat products in the Egyptian market like minced meat, sausage, beef burger and frankfurter.

MATERIALS AND METHODS

Collection of samples

A total of one hundred and sixty randomized samples of restructured meat products, represented by minced meat, sausages, beef burgers and frankfurters (40 of each), were gathered from the several shops located in Shibin Elkom city, Menoufia governorate, Egypt. The following measurements were made for nitrite, phosphate, ascorbic acid, and MSG.

Determination of nitrite (AOAC, 2016)

Mix precisely five grams of sample with 80°C pre-heated water (40 ml). Then further, sufficient hot water was added to make the volume 300 ml, after which the container was shaken for 2 hours in a steam bath. The mixture was cooled to room temperature, diluted with distilled water to make 500 ml, then remixed and filtered. To 10 ml of the filtrate, 2.5 ml of the sulfanilamide reagent were additionally added. After five minutes, 2.5 ml of the NED (N-(1-naphthyl) ethylenediamine) reagent were added, diluted to 50 ml, and mixed. Therefore, a spectrophotometer was used to determine the developed colour within 15 minutes at 540 nm.

Determination of phosphate content (AOAC, 2016)

10 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 dist. water and let stand for 15 minutes in a dark place. Phosphate concentration was determined using a spectrophotometer at 430 nm. Total phosphate was calculated as follow:
Total phosphorus pentoxide = A/(M x 20)
A= concentration of phosphorus pentoxide in sample as a reading from standard curve (µg /ml).

M= weight of sample (gram).

Natural phosphorus in meat = protein % x 250\10000 (µg /g).

Added phosphate = Total phosphate - Natural phosphate.

Determination of ascorbic acid (AOAC, 2016)

Preparation of test sample solution

Twenty grams of the examined sample were mixed with 85 ml dist. water and let stand for 10 minutes. Aqueous solution was filtrated through a funnel containing glass wool into second beaker.

Procedure

Accurately, 0.4 ml CH3COOH-HPO3 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).

Determination of Monosodium glutamate level was performed following the recommendations of Lateef *et al*. (2012) 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).

The Egyptian standards (EOS) acceptability references

EOS, No 1694-2005 for minced meat

EOS, No 1972-2005 for sausage

EOS, No 1688-2015 for beef burger

EOS, No 3492-2015 for frankfurter

Statistical analysis

Tukey-Kramer test was used to evaluate whether a difference was statistically significant ($P<0.05$). The statistical analyses were carried out using the JMP program (SAS Institute, Cary, NC, USA).

RESULTS

Regarding the results obtained in Table 1, the level of nitrite content (ppm) in the examined meat products samples were ranged from 13.7 to 115.4 with a mean value 52.14±2.06 for sausage samples, 9.5 to 102.8 with an average 49.63±2.35 for beef burgers and 8.1 to 73.5 with a mean value 28.59±1.71 for frankfurter samples, while failed to be noticed in minced meat samples. In addition, Fig. 1 showed the acceptability percentage of the examined samples regarding their nitrite contents according to the Egyptian standards "EOS", in which 92.5%, 97.5% and 100% of the investigated sausage, beef burgers and frankfurters samples, respectively, were within acceptable limits (≤ 100 ppm) and accepted.

Analysis of phosphate content (%) in the investigated samples was mentioned in Table 2, in which the phosphate content varies from 0.4 to 0.9 with an average 0.61±0.01 for beef burger and varies from 0.1 to 0.5 with an average 0.34±0.01 for frankfurter samples, while it was not found in sausage and minced meat samples. The acceptability of the examined samples in relation to their phosphate content as recorded in Fig. 1, found that all the examined beef burger samples were above the MPL of phosphates (≤ 0.3 %), while 72.5% of the examined frankfurter

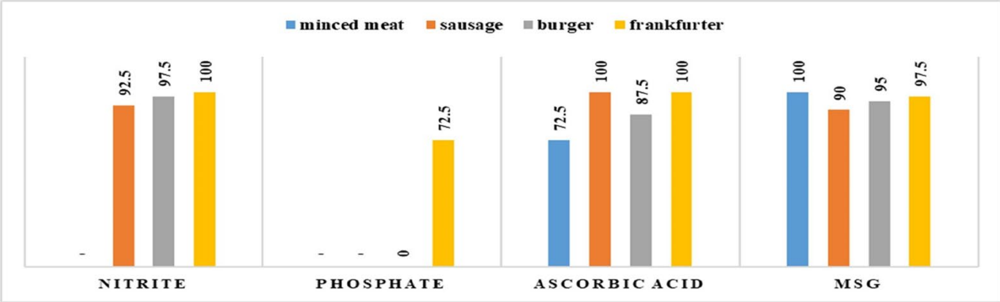

Fig. 1. Acceptability (%) of the examined samples.
NB. (-) means that parameter was not listed in the reference standard.

samples were within the acceptable limit.

Table 1. Analysis of nitrite contents (ppm) in the examined samples of restructured meat products (n=40).

Meat products	Min	Max	Mean±S.E
Minced meat	--	--	--
Sausage	13.7	115.4	52.14±2.06[a]
Beef burger	9.5	102.8	49.63±2.35[b]
Frankfurter	8.1	73.5	28.59±1.71[c]

*Mean values with different superscript letters are significantly differed (P<0.05)

Table 2. Analysis of phosphate contents (%) in the examined samples of restructured meat products (n=40).

Meat products	Min	Max	Mean±S.E
Minced meat	--	--	--
Sausage	--	--	--
Beef burger	0.4	0.9	0.61±0.01[a]
Frankfurter	0.1	0.5	0.34±0.01[b]

* Mean values with different superscript letters are significantly differed (P<0.05)

The results in Table 3 determined the level of ascorbic acid content (ppm) in the examined restructured meat products samples in which it varies from 183 to 659 with an average 393.8±15.7 for minced meat, 125 to 381 with a mean value 226.3±10.9 for sausage, 149 to 527 with an average 301.5±9.4 for beef burgers and 110 to 230 with an average 152.2±7.1 for frankfurter samples; and when it was compared with the allowed Egyptian standards limits, 72.5%, 100%, 87.5% and 100% for minced meat, sausage, beef burgers and frankfurters samples were compatible with the EOS limits (≤ 500 ppm), respectively (Fig. 1).

Table 3. Analysis of ascorbic acid contents (ppm) in the examined samples of restructured meat products (n=40).

Meat products	Min	Max	Mean±S.E.
Minced meat	183	659	393.8±15.7[a]
Sausage	125	381	226.3±10.9[c]
Beef burger	149	527	301.5±9.4[b]
Frankfurter	110	230	152.2±7.1[d]

* Mean values with different superscript letters are significantly differed (P<0.05)

The results in Table 4 detected the level of MSG contents (ppm) in the investigated samples of restructured meat products in which it varies from 897 to 1915 with an average 1367.4±73.6 for minced meat, 2280 to 5469 with an average 3551.8±94.7 for sausage, 1624 to 5110 with an average 3246.5±85.1 for beef burgers and 1870 to 5085 with an average 2998.3±79.8 for frankfurters samples; and through recording the acceptability of the examined samples in Fig. 1, found that 100%, 90%, 95% and 97.5% of minced meat, sausage, beef burgers and frankfurters samples were accepted according the listed Egyptian legislations (≤ 5000 ppm), respectively (Fig. 1).

Table 4. Analysis of monosodium glutamate contents (ppm) in the examined samples of restructured meat products (n=40).

Meat products	Min	Max	Mean±S.E.
Minced meat	897	1915	1367.4±73.6[d]
Sausage	2280	5469	3551.8±94.7[a]
Beef burger	1624	5110	3246.5±85.1[b]
Frankfurter	1870	5085	2998.3±79.8[c]

* Mean values with different superscript letters are significantly differed (P<0.05)

DISCUSSION

Different amounts and concentrations of preservatives are often utilized. The conventional goals of food preservation are to maintain the food's attractive appearance, keep its nutritional content, and lengthen the time it may be stored. Chemical preservation techniques, when combined with refrigeration, are very beneficial for maximizing stability and product quality while maintaining freshness and nutritional content (Samal *et al*., 2017).

Nitrite salts, which function as a flavoring ingredient and have antibacterial properties, were the extremely active curing preservatives. Achromobacter, Aerobacter, Escherichia, Flavobacterium, Micrococcus and Pseudomonas species in meat were inhibited by 200 ppm sodium nitrite and a pH of 6.0. The current limits for nitrite in food are 200 ppm in Canada for meat products and 156 ppm in the US (DJC, 2009). While, according to Egyptian Organization for Standardization (EOS, 2005) it must not be over 100 ppm.

The obtained nitrite levels (ppm) in the current study (Table 1) were lower than those recorded by Nayel (2013) (127.15 and 94.04 for sausage and burger, respectively), Alsuhaibani (2013) (85.99 and 91.63 for sausage and burger, respectively), EL-Zahaby (2013) (125.25 and 176.8 for sausage and burger, respectively), Maky *et al*. (2020) (106.88 ppm for the examined sausage samples) and Khalafalla *et al*. (2022) (82.0 and 45 ppm for sausage and burger samples, respectively), while higher than those recorded by Shaltout *et al*. (2020) (27.59 and 39.81 for sausage and burger, respectively). Although for frankfurter, the level of nitrite was lower than that recorded by Saad *et al*. (2018) (59.29 ppm) and Khalafalla *et al*. (2022) (114 ppm), but higher than that recorded by Jackson *et al*. (2011) where nitrite levels in frankfurters ranged from 1 ppm to 65 ppm.

According to obtained results of phosphate contents (%) (Table 2) for burger samples, its level is higher than those recorded by EL-Zahaby (2013) (0.399 %) Nayel (2013) (0.43 %), Salim and Abo El-Roos (2013) (0.4 %), Hassan *et al*. (2018) (0.21 %), lower than those recorded by Khalafalla *et al*. (2022) (1821, 1638 and 2221 ppm in the examined sausage, burger and frankfurter samples, respectively).

By comparing the obtained ascorbic acid levels in the investigated samples (Table 3), higher results were recorded by Nayel

(2013) (487.82 and 417.67 ppm for burger and sausage, respectively), but lower results were documented by Hassan *et al*. (2018) (111.33 and 227.6 ppm for minced meat and beef burger, respectively, but it was higher in sausage samples than the current obtained results 265.67 ppm).

Regarding the results in Fig. 1, 11/40 (27.5%) from minced meat, and 5/40 (12.5%) from beef burger samples exceeded the permissible limits that was determined by the Egyptian standards, in which ascorbic acid content in meat products should be less than 500 ppm.

Table 4, explained the content of MSG (ppm) in the investigated samples. In which its levels were greater than those detected by Rodriguez *et al*. (2003) (145.7 ppm), Afraa *et al*. (2013) (160 ppm), Hassan *et al*. (2018) (139.9 ppm) and Ayad *et al*. (2022) (173.0 ppm) for beef burger. On the other hand, MSG in sausage samples was higher than the reported results by Hassan *et al*. (2018) (195.9 ppm), Baciu *et al*. (2020) (0.434 mg/gm) and Ayad *et al*. (2022) (275 ppm); while, higher results were recorded by Baciu *et al*. (2020) (0.178 mg/gm) for frankfurter samples.

Monosodium glutamate is used in foods as a flavor enhancer, it has a distinctive flavour known as umami, which is believed to be different from the other four fundamental flavours of sweet, sour, salty, and bitter. Umami is acknowledged globally as the fifth basic taste (Kurihara, 2015). Hence, monosodium glutamate may be useful in preserving the flavour of foods whose salt level must be decreased. Monosodium glutamate dramatically improved flavour quality while lowering the demand for saltiness. However, it should be remembered that excessive amounts of MSG and other umami ingredients will make meals taste less appealing (Yamaguchiand Ninomiya, 2000).

Variation between different authors may be attributed to variations in the locations where samples were collected, trademarks of the examined samples and variations in the national standards from which the meat products were processed.

CONCLUSION

Many different additives have been used either as a preservative substance or as a curing and flavoring agent. In the current study, nitrite, phosphate, ascorbic acid and MSG were detected in different concentrations. Frankfurter samples were the most compatible meat product with the Egyptian standards. The use of chemical additives, in the absence of health and legislative monitoring, is one of the most used methods of apparent adulteration in meat products, which negatively affects the health of consumers. Therefore, it is advised to tighten control over the concentration and use of chemical preservatives and to conduct continuous updates on national standards in this regard.

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CONFLICT OF INTEREST

All authors have no conflict of interest with other people or organizations that might inappropriately influence or bias this work.

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