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ORIGINAL ARTICLE

Nutritional characterization of various classes of Egyptian beef luncheon

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ABSTRACT

Objectives: The present work was conducted to investigate the nutritional profile of the highly consumed beef luncheon in Egypt. Besides, the potential health hazards associated with the consumption of luncheon were highlighted.
Material and methods: A total of 60 beef luncheon samples were collected from Egyptian markets. They were classified into three classes: A, B, and C based on their prices. The collected samples were examined for their chemical composition by determining moisture, protein, fat, ash, carbohydrate, and energy percentage. The contents of trace elements were also investigated.
Results: The obtained findings showed a comprehensive dissimilarity in the chemical composition. According to the fresh weight base, moisture, protein, fat, ash, and carbohydrate fluctuated from 56.97 to 64.52, 3.50 to 16.10, 4.73 to 13.39, 3.30 to 3.51, and 11.32 to 27.44% w/w, respectively. The highest price class A Egyptian beef luncheon had more accepted nutritive value and dietary energy content. All the examined classes were low in calcium, potassium, zinc, and magnesium. The target hazard quotient indicated that the trace elements did not present any risks for consumers except for sodium. High phosphorous content and high phosphorus–protein ratio were observed in all categories which had a harmful health effect, hence named "new cholesterol."
Conclusion: Based on the information, this study is the leading work that deeply investigated the chemical composition of the Egyptian luncheon classes, and the obtained data could be beneficial to update the nutritional knowledge used by dietitians and the responsible for nutrition assessment and surveillance by the government.

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Introduction

The processed meat products are items containing meat mixed with lipid, water, and other non-meat components. Meat products are rich in a wide diversity of nutritive materials, essential amino acids, minerals, and trace elements [1]. Egyptian beef luncheon is considered as one of the ready-to-eat meat products and highly demanded due to its high biological value, reasonable price, agreeable taste, and easy serving. However, meat products are considered to be risky to human health because there has been a correlation between high ingestion of meat products and some affections, including, heart disease, high blood glucose, tumor, liver, urinary, and lung diseases [2].

The beef luncheon is considered as a traditional meat product widely consumed in Egypt as a cooked meat product. It composed of finely minced meat cured with salt and nitrite and then heat-treated [3]. The price of luncheon depends on the amount of lean meat and the quality of ingredients used in processing [4,5]. However, some meat factories use low quality and inexpensive materials to reduce the price of the products [6]. The customer of beef

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luncheon had a greater intake of calories, protein, trace elements, and lipid relative to non-customers [7].

The knowledge of the content of meat products has a considerable impact on quality control, nutritive importance, practical features, organoleptic characters, shelf life, and price [8,9]. The nutrient content of meat products greatly varies from one product to another due to dissimilarities in the beef cuts, food additives, and preparing methods (curing, salting, drying, heating, etc.) which determine the features of processed meat inclusive the content and sensory properties [10]. Although the increasing consumption of beef luncheon in Egypt, their nutritional profile and the potential impact on human health are poorly understood. We are reporting here the nutritional composition of three classes of beef luncheon dependent on their prices. To the best of the authors' knowledge, the coloration between the price of Egyptian beef luncheon and their nutritive value was uninvestigated before. Besides, there is no detailed research on the mineral content of various classes of Egyptian luncheon. Therefore, this research was planned to estimate the concentration of trace elements in beef luncheon at different prices as well as the estimated daily intake (EDI) and health hazards. The current work would be of interest to the consumers, nutritionists, and healthcare practitioners.

Materials and Methods

Collection and preparation of samples

A total of 60 beef luncheon samples were randomly picked up from different markets in Qena city, Egypt. The samples were categorized into three classes based on their prices [high price (group A), medium price (group B), and low price (group C)]. About 20 gm of each class was collected in hygienic bags and retained in an ice tank throughout the conveyance. The samples were carefully grounded into a blender (Moulinex, Paris, France) and reserved at −20°C. All analyses were carried out at the Laboratory of Food Hygiene and Control, Department of Food Hygiene and Control, Faculty of Veterinary Medicine, South Valley University, Qena, Egypt.

Nutritional analysis

The chemical composition was performed by employing the classical procedures of the Association of Analytical Chemists [11]. For moisture content, the samples were dehydrated in a hot air oven at 125°C until obtaining two successive. The determination of crude protein content was performed by using the Kjeldahl technique. The obtained total nitrogen was multiplied by a constant (6.25) to calculate the protein content [12]. The fat content was determined using Soxhlet extractor. The muffle furnace was employed to determine the ash percentage. Carbohydrates were studied by utilizing the following calculation: 100 − (protein% + fat%+ ash% + moisture%) [12]. Energy content was calculated by multiplying protein, carbohydrate, and fat by constants 4, 4, and 9, respectively [12].

Mineral profile

A total of 5 gm of the well-mixed sample was introduced inside porcelain crucibles, then ashing of the sample by using muffle furnace. The obtained ash was dissolved in 1.5% nitric acid and then completed with distilled water up to 100 ml. The sample was filtrated and the trace elements were determined using a spectrophotometer (Unico-UV-2100 spectrophotometer, USA), and the wavelength was 623, 580, 430, 630, 578, 560, 578, and 630 nm for iron, copper, phosphorous, magnesium, calcium, zinc, potassium, and sodium, respectively [13].

Determination of EDI of trace elements

It was calculated by the following equation described by Meshref et al. [14]:

$$\text{EDI} = \frac{C_{\text{metal}} \times W_{\text{food}}}{\text{BW}} \text{ (mg/kg bw/ day)}$$

where C_{metal} represented the concentration of trace element (mg/kg) on a fresh weight base, and W_{food} indicated the usual daily ingesting by an adult person (60 kg bw) of luncheon, which was considered 120 gm.

Determination of health risk of trace element intake

Target hazard quotient (THQ)

It was estimated by the following equation described by Schonfeldt and Gibson [15]:

$$\text{THQ} = \frac{\text{EDI (mg/kg day)}}{\text{RFD (mg/kg day)}}$$

RFD: reference oral dosed for each trace element. When the value of THQ is less than one, it indicated that the consumer is safe, and there are no health adverse outcomes [16].

Calculation of phosphorus–protein ratio

It was estimated as described by Lou-Arnal et al. [17].

Statistical analysis

The results obtained were subjected to the analysis of variance using SPSS 16.0, and the significance was specified at a level of $p < 0.05$.

Results and Discussion

Recently, the demand for ready-to-eat meat products has increased considerably in Egyptian society as an alternative to the fresh meat shortage and their high price. Meanwhile, various categories of luncheon with different prices are available in markets. The present article is considered unique to evaluate a wide variety of Egyptian beef luncheons. The results obtained were remarkable for a product manufactured in an enormous quantity in Egypt. The current work would be useful for both researchers and manufacturers in improving Egyptian beef luncheon.

Proximate composition

Water percent is one of the most measured items in processed meat owing to its legal value, label criteria, bacterial stability, and meat-manufacturing requirements. The results shown in Figure 1 revealed that the average moisture percentage was 64.52% ± 0.31%, 56.97% ± 0.69%, and 59.58% ± 0.66% for classes A, B, and C, respectively, with a significant difference ($p < 0.05$). The Egyptian Standard Specification [18] demonstrated that the permissible limit of moisture is 60%, i.e., almost nearly similar to the obtained results. Many factors cause the moisture percentage in the examined luncheon to be variable, including the amount of meat used [19]. Moreover, the amount of added water that allows the meat is minced and combined with other ingredients. Similar findings were obtained by Edris et al. [5]. Sabry [20] showed that the moisture content of examined luncheon samples collected from different supermarkets in Egypt was ranged from 57% to 66%. The high moisture content would increase the action of spoilage process obtained by microorganisms. Therefore, the control of moisture in food is necessary [21].

Protein is the primary component of meat, which has a significant function in the development of muscles, and acts as a behoof of energy for consumers. Herein, a large difference in the protein content was identified between the various classes of luncheon examined with a significant difference ($p < 0.05$ each) (Fig. 1). The protein percentage was the top in class A (16.10% ± 0.33%) and the lowest in class C (3.50% ± 0.81%). Moreover, the high protein content of class A was correlated with its high price. On the other side, class C was the lowest price, and this is correlated with its lower protein content compared to other classes. Remarkably, many samples in class C their protein contents were zero, and this may answer the question of why there were wide variations between the prices of luncheon in Egyptian markets.

This dissimilarity in the protein percentage of the different luncheon classes may be due to the amount of meat added. However, the low protein content may be due to substitution with cheaper non-meat ingredients. According to the Egyptian standard specification (ESS) [18], the protein content of Egyptian luncheon should be around 16%. In comparison with the obtained data, 80% of samples of class A agreed with ESS, whereas all of the samples of class B and C did not agree with the ESS, 2005. Comparable findings were achieved by Edris et al. [5]. Various categories of Egyptian luncheon were examined by Sabry [20], and the protein contents were ranged from

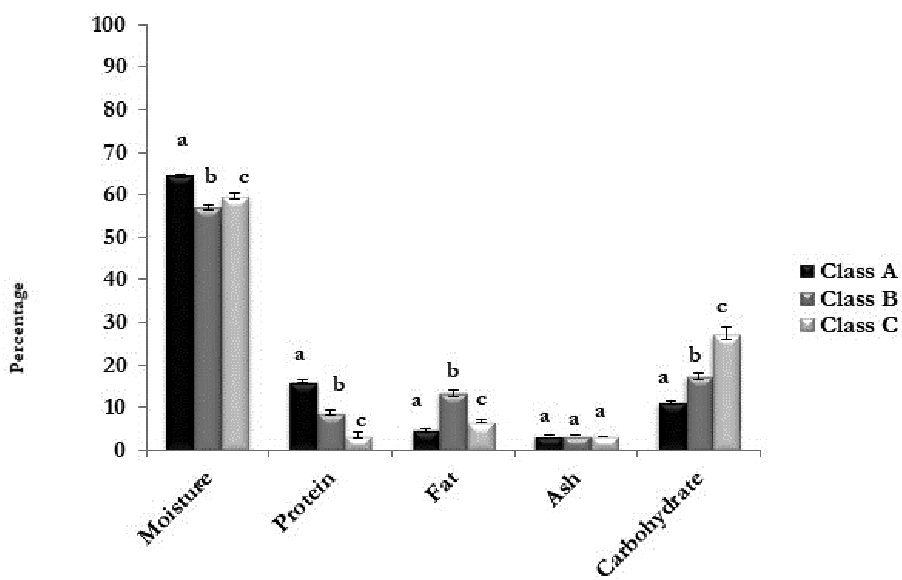

Figure 1. Nutritional profile of various classes of Egyptian beef luncheon. Percentage of moisture, protein, fat, ash, and carbohydrate. Data are mean ± standard error ($n = 20$). Various letters indicated a statistically significant difference between the means at $p < 0.05$.

12.2% ± 0.04% to 15.74% ± 0.3%. Proteins provided the consumers with essential amino acids since the body could not create them and so they needed to be picked up from meat and its products. Therefore, the rigorous measures that guarantee the availability of the permissible limit of protein in Egyptian luncheon should be applied.

In the processed meat, fat had a great influence on organoleptic characters and the durability of the products. Herein, the fat content ranged from 4.73% ± 0.30% (class A) to 13.39 ± 0.75% (class B) with a significant difference ($p < 0.05$) as shown in Figure 1. The high intake of processed meat with great fat content can be a major risk factor for excess weight and obese [22]. The obtained results were lowered than the fat limit described by ESS [18]. It was reported that the variations in the fat percentage may be due to the type of meat cuts used as some of them are high in fat and other low or inappropriate formulation of luncheon [23].

The ash content is a quantification of the total minerals present in meat. The determination of ash in processed meat is needed due to nutritional labeling. For instance, high ash contents might reduce the growth of some bacteria, and the product quality depends on the quantity and quality of the available ash. The ash content of the examined samples was the highest in class B (3.51 ± 0.09), whereas the lowest in class C (3.30 ± 0.05) with no significant difference ($p > 0.05$). The averaged ash content should be 3.5% ESS [18], indicating that class B was the best category in ash content, whereas classes A and C had slightly lower than the permissible limit. Similar results were obtained by Edris et al. [5], whereas Sabry [20] reported a lower ash content for various luncheon brands.

Raw meat usually had trace quantities of carbohydrates. On the other hand, carbohydrate contents in meat products represented non-protein materials, such as starches and cereals. In the obtained results (Fig. 1), the mean carbohydrate value of luncheon samples which were lower than those of Sabry [20]. However, high carbohydrate content in class C may be attributed to the low amount of lean meat as obtained by the analysis of protein percentage and utilization of a high amount of non-meat ingredients. Here, we determined the total carbohydrate content, and different tests can be used to evaluate specific kinds of carbohydrates.

Concerning the energy value of examined samples, class B (228.02 ± 6.14 kcal/100 gm) was the highest source of energy followed by class C (182.00 ± 2.85 kcal/100 gm) and the lowest one was class A (152.96 ± 2.40 kcal/100 gm). The statistical analytical result indicated that the energy value of the examined samples was significantly different ($p < 0.05$). The energy percentage was more acceptable when associated with the everyday requirements. The National Research Council [24] illustrated that the daily allowances of energy for an adult man are 2,900 kcal, whereas for an adult woman is 2,200 kcal. The current study revealed that a 100-gm intake of luncheon class A would provide 5.25% and 6.95%, whereas class B would furnish 7.8% and 10.3% for men and women, respectively. In the same way, 6.2% versus 8.2% of the recommended dietary allowance of energy for men versus women would be taken by the ingestion of 100-gm of class C luncheon.

In a balanced diet, 10%–15% of the overall energy is taken from protein, 55%–75% from carbohydrate, and 15%–30% from fat [25]. Figure 2 shows that class A was agreed with the WHO in dietary energy derived from fat, whereas the total dietary fat in class B and C exceeded 30% of total food energy, indicating that these classes are not suitable for people who suffered from cardiovascular diseases. These findings should be taken into account to design diets with sufficient energy input and evaluate the

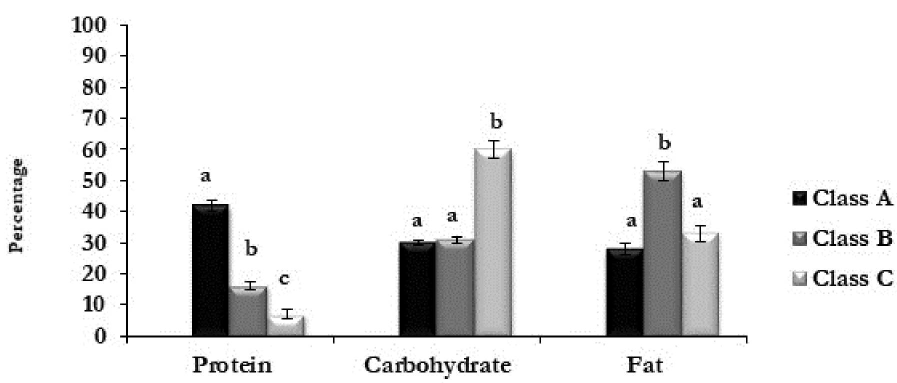

Figure 2. Percentage of energy from protein, carbohydrate, and fat in various classes of Egyptian beef luncheon. Data are mean ± standard error ($n = 20$). Various letters indicated a statistically significant difference between the means at $p < 0.05$.

hazards and gains arising from the existing percentage of energy.

Mineral profile

Figure 3 shows that the calcium content in the various classes of luncheon meat was 18.27 ± 2.60, 15.78 ± 2.75, and 15.42 ± 2.57 mg/100 gm for classes A, B, and C, respectively. Similar values for calcium were reported by Holden et al. [26]. However, Kdous et al. [27] produced a new dried luncheon with a higher calcium content. The variation in calcium content might attribute to the kind of raw materials used to get these products. Calcium is required for normal muscle function, blood clotting, construction of teeth and solid bone, management of the heartbeats, and liquid equalization inside cells. The EDI for calcium (Fig. 4) in luncheon meat was 1.85–2.19 mg/day, which represented 0.18%–0.012% of recommended daily allowance (RDA) values (Fig. 5). Hence, the Egyptian beef luncheon is considered as a poor source of calcium. It is highly recommended that calcium content should be increased to reach RDA.

Phosphorus content in examined samples was significantly high in class B in comparison with other classes. However, Holden et al. [26] obtained a lower level for phosphorus in examined luncheon samples. The utilization of food additives, including phosphorus, can increase the content of phosphorus in processed meat which may act as a hidden source of phosphorus. The presence of phosphorus at high levels can lead to bone disorders and arteriosclerosis, and hence, it is termed "new cholesterol." The recommended phosphorus–protein ratio should be 10–12 mg/gm, and all the examined sample classes showed a high phosphorous–protein ratio (22.82, 64.73, and 98.79 for classes A, B, and C, respectively). Therefore, we should be mindful of the extreme use of phosphorus-containing additive without protein contribution. Chronic kidney disease patients must be aware of this information and should explore the label of products. Moreover, the authority should ask the manufactures of processed meat products to exhibit the true phosphorus content of processed meat. This manufacture should be performed with little phosphorus contents, and the substitutes to phosphorus additives should be utilized.

Potassium is required for the action of enzymes, insulin secretion, regulation of blood pressure, protein synthesis, and carbohydrate metabolism. The proper dietary requirement from potassium protects the human body from hypertension, kidney stones, Alzheimer's disease, arthritis, osteoporosis, and atherosclerosis. The recommended potassium content in luncheon meat was 202 mg/100 gm. Based on the obtained finding, classes A and B had a suitable content of potassium, whereas class C showed low potassium content (Fig. 3). These findings matched with the values obtained by Holden et al. [26]. Hence, an optimal intake of potassium lowers cardiovascular affections. Therefore, the consumption of potassium at an appropriate level is guidance for better health.

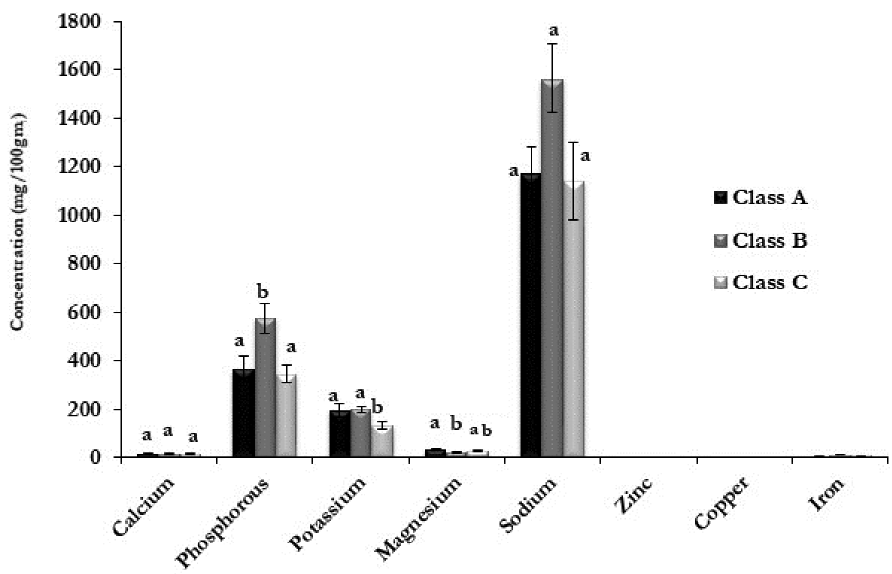

Figure 3. Trace element concentrations in examined luncheon samples (mg/100 gm). Data are mean ± standard error (n = 20). Various letters indicated a statistically significant difference between the means at p < 0.05.

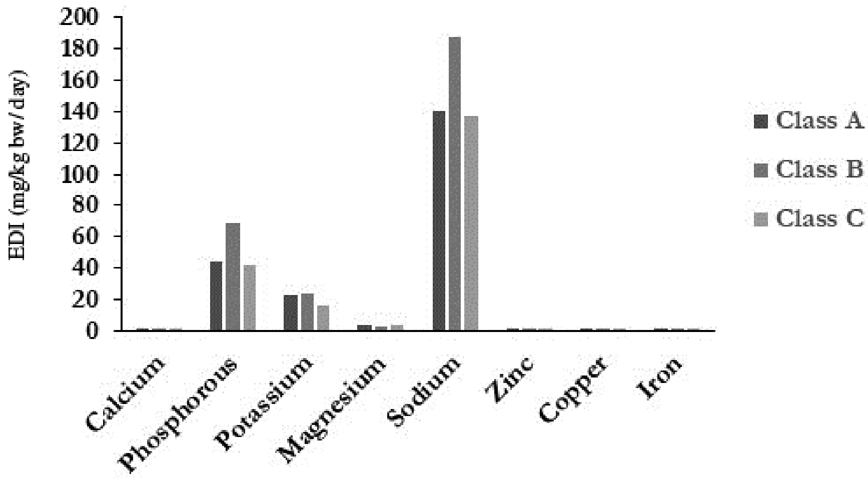

Figure 4. EDI (mg/kg bw/ day) of trace elements via consumption of various class of Egyptian beef luncheon.

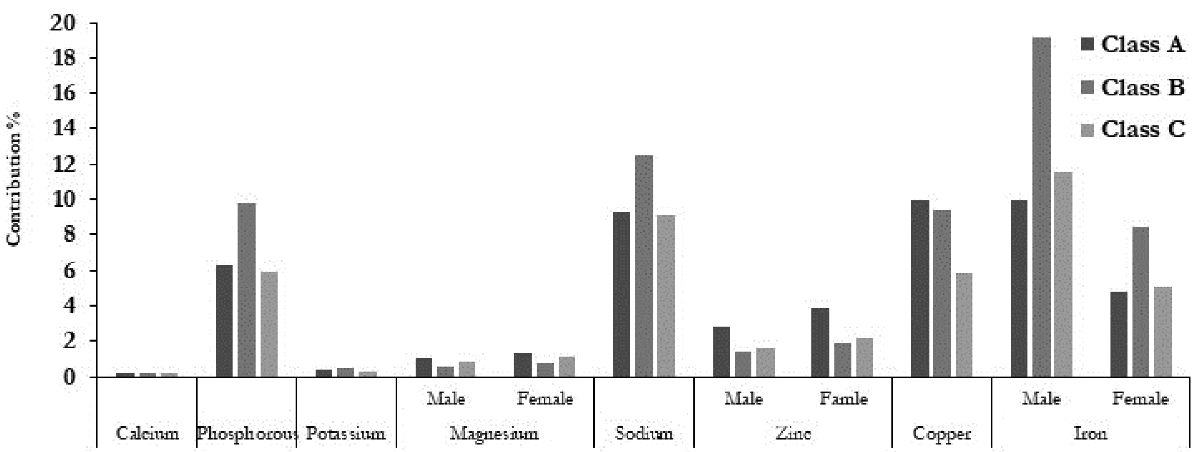

Figure 5. Percentage of the contribution of EDI (mg/day) of trace elements to the RDA values. RDA of calcium: 1,000 mg/day for male and 1,000 mg/day for female. RDA of phosphorous: 700 mg/day for male and 700 mg/day for female. RDA of potassium: 4,700 mg/day for male and 4,700 mg/day for female. RDA of magnesium: 400 mg/day for male and 310 mg/day for female. RDA of zinc: 11 mg/day for male and 8 mg/day for female. RDA of copper: 0.9 mg/day for male and 0.9 mg/day for female. RDA of sodium: 1,500 mg/day for male and 1,500 mg/day for female. RDA of iron: 8 mg/day for male and 18 mg/day for female.

Magnesium content was significantly high (35.6 ± 3.97 mg/100 gm) in class A luncheon in contrast with another category (Fig. 3). The analogous value was reported in the examined processed meat [28]. Magnesium is a fundamental element used in the metabolism, hormones synthesis, cell membrane integrity, and activity of muscle. The EDI for magnesium in the examined samples was ranged from 2.59 to 4.27 (mg/day) (Fig. 4), which represented 0.64%–1.06% and 0.83%–1.38% of the RDA values for men and women, respectively (Fig. 5). Magnesium has multiple functions for the human body including protein constructing, neuronal role, bone development, blood pressure control, and cardiovascular electrical transmission. Nonetheless, excess magnesium intake can lead to bad health problems [29].

Sodium is an element desired by the human body for different roles, including regulating blood pressure. An higher intake of sodium more than 2 gm/day as suggested by the WHO is incriminated in hypertension, renal disease, liver affections, and tumors in the stomach. In the current study, the sodium content was in the ranges of 1140.41

± 161.80–1563 ± 142.33 mg/100 gm (Fig. 3). According to the regulation of the WHO [25], the processed meat contributed relatively 10% of every day sodium intake. The classes A and C of examined luncheon samples have very close values to the acceptable contribution of daily sodium intake, unlike class B which exceeded the limit. These results emphasize that there is an urgent need for government regulations to reduce the sodium content in luncheon meat and enhance the consumer awareness for healthier processed meat. Furthermore, sufficient information should be presented in the label to support the consumer choice.

Zinc content was significantly higher in class A (2.62 ± 0.14 mg/100 gm) in comparison with other categories. However, the lower value was obtained by Hamasalim and Mohammed [30]. Such dissimilarities may be attributed to various reasons, including the variability of meat chemical composition and the different manufacturing operations. Zinc is compulsory for the activation of enzymes of the human body, synthesis of protein and DNA, cell development, wound cure, maintenance of the immune system, blood coagulation, bone integrity, and sperm production. The shortage of signs of zinc includes weight loss, inappropriate growth, fatigue, low blood pressure, and maximizing the risks of disease infection. The EDI for zinc in luncheon meat started from 0.15 to 0.31 mg/day, which represented 1.41%–2.85% and 1.95%–3.93% of the RDA value for male and female, respectively (Fig. 5). The central agency for standardization and quality control stated that zinc concentration in luncheon should not exceed above 50 mg/kg, indicating that all the examined samples were poor in zinc content.

Luncheon samples of classes A and B were rich (0.75 ± 0.13 mg/100 gm and 0.71 ± 0.13 mg/100 gm, respectively) in copper than those samples of class C. The obtained values were lower than the value obtained by Hamasalim and Mohammed [30]. Copper is required for enzyme activation, gene expression, neuroendocrine task, the formation of red blood cells, and the creation of connective tissue. The EDI of copper in examined luncheon samples was ranged from 0.05 to 0.09 mg/day (Fig. 4), which contributed from 5.8% to 10% of the RDA (Fig. 5).

Iron content in luncheon meat was ranged from 7.25 ± 0.79 to 12.81 ± 1.04 mg/100 gm. The obtained values for iron were greater than the values reported by Nunes et al. [28], Holden et al. [26], and Hamasalim and Mohammed [30]. The examined samples had iron content more than the iron content of raw meat (1.2 mg/100 gm). It might relate to adulteration by the plant of the high amount of iron, especially soybean which contains 14.5 mg/100 gm. Iron has multiple beneficial roles including oxygen transfer and participates in metabolism as it is a constitute of some enzyme and protein. However, the high iron ingestion from meat and their product may result in heart diseases and cancer. The governing authority in Egypt needs to ensure that customers have not only a reasonable intake of iron but also a range of iron-containing food. Further analysis to determine the source of iron in processed meat should be needed.

Health hazards

THQ has been known as a helpful tool for the assessment of hazards accompanied by the consumption of luncheon meat. It is a proportion of the evaluated dose of trace elements to a reference oral dose administration. The THQ below 1 referred to that the exposed people is expected to be harmless [16]. Herein, the THQ of all examined trace elements, except sodium, was less than 1 through the consumption of luncheon meat (Fig. 6), whereas THQ above 1 indicated that the level of sodium consumption

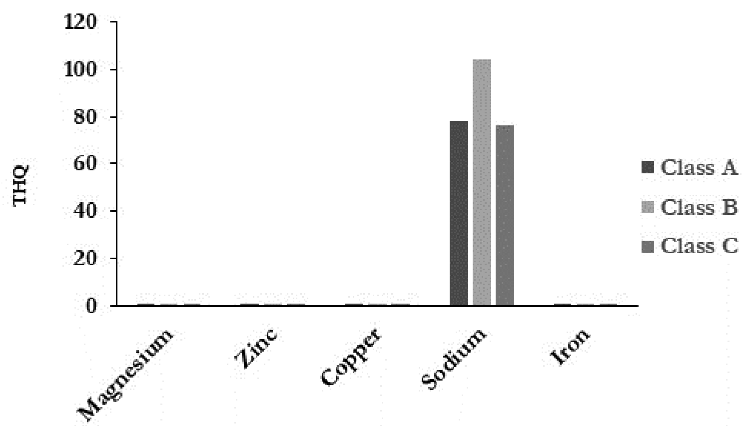

Figure 6. THQ for some trace elements through the consumption of various classes of Egyptian beef luncheon. Reference oral doses are 11, 0.3, 0.04, 0.03, and 0.7 for magnesium, zinc, copper, sodium, and iron, respectively.

was greater than the oral reference dose, and the daily exposure at this dose can be a reason for bad health effects for the human community throughout a life span [31]. Based on THQ data, it indicated that consumers were not susceptible to a potential medical hazard from the consumption of various classes of luncheon except higher THQ value for sodium. Sobhanardakani [32] determined zinc and copper in the samples of processed meat collected from Iran and concluded that there was no probable health hazard for the consumer through the consumption of processed meat. Therefore, we uniquely highlighted the risk of the presence of sodium in Egyptian beef luncheon.

Owing to the relatively small sample size of the collection which may be considered as a limitation, further studies with a broader set of samples may be interesting. Therefore, the use of a similar strategy for further nutritional investigations on this variety of processed meat commonly consumed in Egypt is needed such as bacon, sausage, ham, salami, pastrami, corned beef, bologna, and hot dogs which will deepen the database of food sciences.

Conclusion

The current study provided important data about the proximate composition and trace elements contents of different classes of Egyptian luncheon. The high price class A luncheon meat was rich in protein with acceptable dietary energy derived from fat. However, special attention should be given to high sodium and phosphorus contents in Egyptian beef luncheon. The sodium level should be reduced by using other salt types. Therefore, the consumer should review the label of luncheon, and the label should display the real contents of trace elements and support the consumers in achieving dietary guidelines.

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Conflict of interests

The authors declared that they have no conflict of interest.

Authors' contributions

M.A.M. and M.S. planned the study and gathered the data. All authors were discussed the data and drafted the paper.

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