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Assessment of Street Vended Foods in Gharbia Governorate Vs Laboratory Foods: Approximate Chemical Composition and Heavy Metals

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THE CURRENT study compared the same food products that were produced in a lab to random samples of street food sold in two cities (Tanta and Kafr-Elzayat) in the Gharbia governorate of Egypt. These foods included animal-based items e.g., chicken shawarma, beef shawarma, hawaweshi, and plant-based items like Taamia and Koshary. Samples were gathered and chemically analyzed to determine their moisture, protein, fat, ash, and carbohydrate content. Results of heavy metal assessment showed that both plant-based and animal-based street-vendor foods had cadmium and lead content that were higher than the EOS-permitted levels (2005). Regarding the area, Kafr-Elzayat city and Tanta city showed the greatest levels of cadmium and lead contamination, respectively. As street vendors add low-cost and subpar components at varying percentages to increase their profits, the acquired results showed that the mean values in the tested samples were considerably different from laboratory products to street products.

keywords: Pollution; Heavy metals; Lead; Contamination; Foods; Health; Cadmium.

1. Introduction

Globally, people are very concerned about food safety. Research on the dangers of consuming foodstuffs polluted by pesticides, heavy metals, and/or toxins has been spurred during the past few decades by the growing need for food safety **(D'Mello, 2003)**. Food consumption has been identified as the primary method by which people are exposed to heavy metals, and thus poses a hazard to public health **(Gomaa and Elhadidy,2020)**. Research on the dangers of eating food polluted with heavy metals has accelerated due to the rising need for food safety **(Mansour *et al.*, 2009)**. Foods that are damaged or tainted because they either contain microorganisms, such as bacteria or parasites, or toxic compounds that render them unsafe for consumption are often referred to as “contaminated foods”. It is more typical for food contaminants to be biological than chemical or physical. Pesticides, heavy metals, and other foreign chemical agents are examples of chemical food pollutants that may get into the food supply chain **(Malik, 2016)**.

Over the past few decades, heavy metal pollution in the environment has been regarded as one of the world's most severe issues. Low quantities of heavy metals may exist in agricultural soils, but plants can acquire them over time. To avoid their negative effects and to evaluate whether they are suitable for human consumption, researchers from throughout the world are studying the pollution of air, water, and food by heavy metals **(Naeem *et al.*, 2009; Nkansah and Amoako, 2010; DekoFehinti *et al.*, 2012)**. Heavy metal toxicity can interfere with the operation of organs such as the kidneys, lungs, and liver as well as disrupt central nervous system development and mental development **(Hajeb and Sloth, 2014).** Excessive levels of heavy metals from anthropogenic sources that penetrate the ecosystem can cause bioaccumulation and geo-accumulation, which can contaminate the environment and the food chain and endanger human health **(Weldegebriel *et al.*, 2012)**. The accumulation of heavy metals like cadmium and lead in the human body has been related to immunological suppression, chemical sensitivity, breast cancer, a decrease in sperm count, and infertility. According to the classification, cadmium may cause human cancer. Chronic exposure to cadmium is linked to a variety of additional illnesses, such as renal and liver disease, heart disease, anemia, skeletal deterioration, and suppressed immune response **(Codex Alimentarius Commission Procedural Manual, 2001)**. Lead is known to be a

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hazardous chemical that accumulates in the body. Additionally, excessive lead levels in meals sold on the street are linked to chronic lead toxicity, which can cause anemia, stomach pain, encephalopathy, and kidney impairment. Lead is now thought to be an immunosuppressive substance that affects both animal and human immune systems **(Daland, 2000)**.

For people who are forced by circumstance to eat away from their homes, ready-to-eat foods prepared and sold by restaurants and street vendors offer a source of readily available, affordable, and nutritional meals without further thermal treatments and at reasonable prices **(Hussein *et al.,* 2018)**. They also have an agreeable taste and are simple to serve. When it comes to street food, their poor quality, poor production conditions, use of subpar ingredients, and poor vendor staff hygiene lead to their contamination with toxins, heavy metals, and germs, making them harmful to the health of consumers **(Younis *et al.,* 2019 and Al-Moalem, 2022)**.

The goal of the current study is to compare specific street foods offered in Tanta and Kafr-Elzayat, two cities in Egypt, to similar food items created in a lab and to assess the nutritional value and heavy metal contamination of those foods.

2. Materials and Methods

2.1. Samples collection

A total of 100 samples of ready-to-eat sandwiches from random restaurants were gathered (10 of each item from each city) in the distinct inner congested (moving) centers of Tanta city and Kafr El-zayat city in the Gharbia governorate of Egypt. Such food samples comprised 5 pieces of various popular sandwiches that were more sought and devoured more frequently:

- animal-based products: Chicken Shawarma, Beef Shawarma, and Hawaweshi
- Plant-based products: Taamia and Koshary.

2.2. Laboratory Food Products

The following food products were prepared in a laboratory using commercial ingredients following a common traditional method:

- Chicken Shawarma sandwiches are prepared by stuffing bread with chicken shawarma, which is made by skewering pieces of marinated chicken or raw chicken into a huge spinning cone. Behind the actual cone are onion or tomato slices and animal fat. A chef uses a huge knife to slice the meat thinly and transfers it to a circular tray below where it can be picked up. Onion, tomato, lettuce, and prawns are the main ingredients in shawarma, and the dressing is created with Tahina, vinegar, and spices.
- Beef Shawarma sandwiches are made from bread stuffed with beef shawarma, which is made from frozen meat that has been defrosted at room temperature (22±3°C) for 4-5 hours, dressed by removing the surrounding fat layers, cut into portions measuring 10 cm in thickness and then into small slices measuring 4-5 mm in thickness using stainless steel knives, kept in stainless steel nets to separate blood, then thoroughly mixed with chopped onions, spice blends, salt, vinegar, and water, then stored before adding the fat to the chilled meat mixture. The fat was trimmed to remove non inedible areas, split into small pieces, and minced with a meat mincer to pass through 3 mm.
- The hawaweshi loaf is made of bread filled with chopped meat, veggies, and spices. This is cooked until the meat has matured in an oven.
- Taamia is produced from powdered beans and a mixture of vegetables, which are then shaped into little cakes and fried in oil.
- Koshary is a popular meal formed of rice, lentils, chickpeas, pasta, fried onion, and ketchup.

2.3. Chemical analysis

The proximate analysis in terms of moisture %, protein % fat%, ash%, and carbohydrate% were determined according to the **AOAC (2000)**. Heavy metals (cadmium Cd and lead Pb) in all food items were measured by Atomic Absorption Spectroscopy (ICP = inductively coupling plasma unit: optima 7000 DV) following wet digestion with an HNO3: H2O2 (1:1v/v) mixture as described by **Olaifa *et al.,* (2004) and Ragab *et al.,* (2016)**. In brief, A 50 ml prewashed glass beaker was filled with about 2 gm of samples. 25 ml of HNO_3:H_2O_2 (1:1 v/v) were added, and the beaker was covered with glass. Digesting took place for two hours at 160 °C. To minimize the digest mixture (to around 1 to 2 ml), the glass watch was shifted. After that, room temperature cooling was allowed. The digested mixture was volumetrically transferred into a 25-ml volumetric flask, and distilled water was added until the mixture reached the desired volume. Atomic absorption spectroscopy was performed on the digested solution. The findings were given in mg of the metal per kg of the sample (mg/kg).

2.4. Statistical analysis

Data were examined using Analysis of Variance (ANOVA) and means were separated by Duncan at a probability level of < 0.05 (SAS, 2000).

3. Results and discussion

3.1. Proximate chemical composition

Table (1) and Figure (1) compare the chemical content of three different food products generated in a lab with those produced in two different cities. Although the types of street snacks vary greatly from location to location, generalizations from the scant few analyses that have been conducted are possible. Table (1) and Figure (1) provide examples of several significant nutritious components of foods sold on the street. The findings indicated that these foods had a significant number of nutritious components. Hawaweshi and shawarma sandwiches made with beef or chicken are more calorie-dense and go well with a sedentary lifestyle. They contain meat, which is made up of protein, lipids, vitamins, minerals, and other bioactive substances, in addition to minor amounts of carbs. The high-quality protein in meat, which contains all nine essential amino acids as well as highly accessible minerals and vitamins, is what gives it its nutritional significance **(FAO, 2013)**.

The mean values for moisture content, protein content, fat content, and carbohydrate content were close to those found in a previous **study (Sulieman et al., 2012)**. For instance, the moisture level of the Shawarma samples ranged from 45.76 to 40.42 % in every Shawarma sandwich. The different cooking methods could be to blame for this variation in moisture content. According to reports, processing can cause the water content of many beef products to drop. Care must be taken to preserve the meat's nutritive and organoleptic (taste, smell, texture, and appearance) qualities during these operations **(Lawrie 1991)**.

It was evident that compared to foods sold on the street, laboratory-produced food had higher protein and lower fat content. For instance, the protein and fat content of chicken Shawarma in laboratory goods was 18.55 % and 10.91 %, respectively. In street food sold in Kafr El-zayat city, protein content dropped to 12.77% and fat content rose to 17.41 %. Additionally, the lipid content in the items sold at Tanta Street vendors considerably increased from 13.29 % in laboratory Hawaweshi to 18.58 %. According to several reports, the amount of high-quality protein found in meat directly correlates with its nutritious worth. Essential amino acids, which our bodies are unable to produce but which must be obtained through food, are found in high-grade proteins. Meat-based foods have an edge over those made from plants in this regard. The type of meat and the additives used may be responsible for the variance in protein content **(Lawrie, 1991)**.

Because fat can provide two times as much energy as proteins and carbs, it is a significant source of energy. Triglycerides make up the majority of the fat in the meat. Meat tenderness and roughness are substantially influenced by the triglyceride content. Additionally, a fat reduction may have an impact on the physicochemical attributes and sensory qualities, particularly the aroma of cooked meat. Since lipid oxidation and its interactions with other dietary components produce huge amounts of volatile chemicals (Mottram, 1998). However, its high-fat content, particularly in saturated fatty acids and cholesterol, may be harmful to human health **(Sylvia *et al.*, 1994)**. In Egypt, additional saturated fat is added to the commercial preparation of shawarma and Hawaweshi to enhance the flavor of the grilled food. A high prevalence of obesity, diabetes mellitus, and coronary heart disease may result from such an addition, which may also alter the product's technological features, storage capabilities, and nutritional value.

Table 1. Proximate chemical composition of street vended foods (meat products) compared with the same products made at the laboratory.

Products		Moisture	Protein	Fat	Ash	Carbohydrate
Lab	Chicken Shawarma	44.62± 1.28^{ab}	18.55±0.49^{a}	10.91±0.90^{ed}	1.13±0.03 ^{b}	24.77±2.61^{a}
	Beef Shawarma	45.63±1.23^{a}	17.58±1.22^{a}	9.48±0.63^{e}	1.26±0.16^{ab}	26.04±3.20^{a}
	Hawaweshi	40.51±1.38^{b}	16.78±0.66^{a}	13.29±0.5^{cd}	1.33±0.23^{ab}	28.07±2.31^{a}
Tanta	Chicken Shawarma	45.75±1.27^{a}	13.45±0.92^{b}	16.29±1.07^{abc}	1.45±0.06^{ab}	23.02±3.18^{a}
	Beef Shawarma	45.76± 1.28^{a}	12.07±2.11^{b}	14.85±2.05^{bc}	1.41±0.12^{ab}	25.89±5.51^{a}
	Hawaweshi	40.42±1.61^{b}	11.73±0.75^{b}	18.58±1.18^{a}	1.52±0.05 ^{a}	27.72±1.14^{a}
Kafr Elzayat	Chicken Shawarma	43.44±1.25^{ab}	12.77±1.06^{b}	17.41±0.38^{ab}	1.39±0.08^{ab}	24.96±2.13^{a}
	Beef Shawarma	45.48±1.52^{a}	11.73±0.21^{b}	15.91±0.35^{abc}	1.46±0.06^{ab}	25.42±1.62^{a}
	Hawaweshi	42.65±0.39^{ab}	12.48±0.58^{b}	18.24±0.50^{a}	1.49±0.01^{ab}	25.12±1.33^{a}
Significance		**0.0305**	**0.003**	**0.001**	**0.354**	**0.960**

The sample contained ash of between 1.13and 1.49 %. The items' ingredients may be criticized for the proportional rise in ash content when compared to lab-produced goods. A similar justification was provided by **Hassan (2005)**, who found that variations in ash values were caused by the type of cooking, the temperature at which it was done, as well as the number of components used.

Figure 1 compared the chemical composition of Taamia and Koshary sold on the street to Taamia and Koshary synthesized in a lab. It was obvious that the moisture content of Taamia differed from that of Koshary. Additionally, the moisture level of food products in laboratories varied from that of meals sold on the street. In the laboratory Taamia and Koshary, it was 34.74 % and 49.54 %, and in the street Taamia and Koshary, it was 28.52 % and 47.58 %.

In terms of protein, Taamia and Koshary, particularly in lab foods, contained substantial amounts of plant protein. 14.35 % and 10.30 %, respectively, were present. In Tanta city's streets Taamia and Koshary, these sums drastically dropped (7.73 % and 6.74 %). This drop may be the result of vendors increasing the level of carbohydrates in their products to boost sales. Whereas previously, laboratory Taamia and Koshary had carbohydrate content of 35.43 and 33.50 %, respectively, street products now have 43.58 and 37.27 %. In terms of fat content, we can state that the amount of fat and ash in foods sold on the street greatly rose. For instance, the percentage of fat went from 13.43% at Taamia Laboratory to 17.73% in Taamia Street. Taamia had high fat and calorie content since they absorbed oil during the frying process for a long time. Nearly all of the results in Figure (1) matched the values that were reported by **Dashti *et al.*, (2001)**.

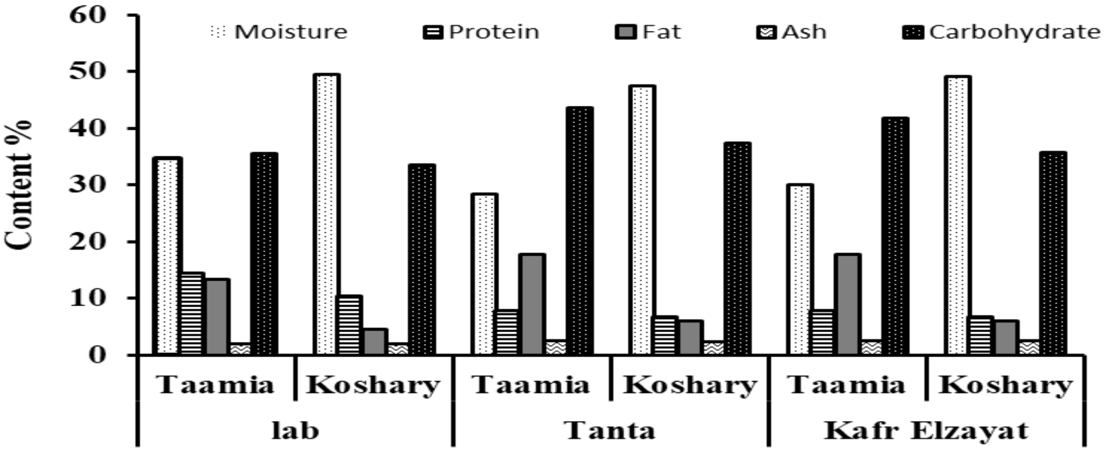

Fig. 1. proximate chemical composition of some street vended foods (plant products) compared with the same products made at the laboratory.

3.2. Heavy metals contents

Lead and cadmium levels in meals (meat products) sold on the street were shown in Table 2. It was clear that lead amounts in 20–30% and 40–50% of the laboratory and street samples, respectively, were undetectable. Additionally, cadmium amounts in 20–30% and 60–70%, respectively, of street and laboratory samples were not found. As for the lead and cadmium concentrations found in the remaining samples, we can remark that they were higher than allowed in all street foods (from Tanta and Kafr Elzayat cities) but were below allowed in laboratory items. For instance, the mean lead values in laboratory products for chicken shawarma, beef shawarma, and Hawaweshi were 0.079, 0.096, and 0.063 ppm, respectively.

They were lower than permissible limits detected by the **Egyptian Organization of Standardization "EOS" (2005)**. It was distinct from street food because lead levels in chicken shawarma, beef shawarma, and Hawaweshi in Tanta city products were 1.22 ppm, 1.15 ppm, and 1.42 ppm, respectively, but they were 2.12 ppm, 1.49 ppm, and 2.028 ppm in Kafr Elzayat city products. They went beyond what was allowed in Egypt. The laboratory concentration used in this investigation (which did not exceed permitted limits) was very similar to that of **Fatin, (1998), Sharkawy and Amal (2003), El-Sakkary (2007), Essa *et al.* (2007), Abd El-Mageed-Walaa (2013), and El-Sharawy-Nagwa (2015)**. Street food vendors' heavy metal concentrations, which were over permitted levels in this study, were similar to those found in previous research **(Morshdy *et al.*, 2000; Shaltout *et al.*, 2003; El-Tawwab 2004; Gonzalez-Weller *et al.*, 2006; Iwegbue *et al.*, 2008 Abdulmajid *et al.*, 2014 and Elsisy *et al.*, 2017)**. The same is a fact for cadmium levels, which were lower than the limits in laboratory products and beyond the allowed limits in Tanta and Kafr Elzayat cities.

Because heavy metals are extremely poisonous and harm human health, they are a severe problem that warrants serious consideration in meals of animal origin like poultry meat and other protein sources **(Umer *et al.*, 2017)**. High levels of heavy metals in all meat products can be attributed to contamination of drinking water and chicken feed. Vehicle emissions and filthy slaughterhouses are two more causes of pollution **(Ghimpeteanu *et al.*, 2012)**. The widespread environmental contamination may be to blame for the high levels of Pb and cd found in Shawarma and Hawaweshi sandwiches **(Dutta *et al.*, 2005)**. **Shaheen *et al.* (2005)** reported that traffic emissions of lead (Pb) in industrial activities for manufacturing batteries, bearing metals, cable covering, gasoline additives, explosives and ammunition, antifouling paints and analytical reagents have caused widespread environmental contamination. These emissions come from contaminated fumes and effluents of local industries and high levels of airborne trace metals (Pb, Mn, Cd).

Table 2. Lead and cadmium concentrations (mg/kg) in samples of street food (meat items) with those found in laboratory goods. (n=10).

		Lead			Cadmium		
		Maximum Permissible Limit ($mg\ kg^{-1}$)*	%	Mean values ± S.E**	Maximum Permissible Limit ($mg\ kg^{-1}$)*	%	Mean values ± S.E**
Lab	Chicken Shawerma	0.1	40	0.079±0.056 e	0.05	30	0.034±0.008 b
	Beef Shawerma	0.1	40	0.096±0.007e	0.05	30	0.040±0.015b
	Hawaweshi	0.1	50	0.063±0.02e	0.05	40	0.030±0.005b
Tanta	Chicken Shawerma	0.1	70	1.22±0.12cd	0.05	70	0.32±0.09a
	Beef Shawerma	0.1	80	1.15±0.041d	0.05	70	0.477±0.065a
	Hawaweshi	0.1	80	1.42±0.11cb	0.05	80	0.449±0.111a
Kafr Elzayat	Chicken Shawerma	0.1	80	2.12±0.112a	0.05	70	0.345±0.060a
	Beef Shawerma	0.1	70	1.49±0.10b	0.05	70	0.52±0.075a
	Hawaweshi	0.1	70	2.028±0.101a	0.05	70	0.536±0.11a
	Significance	-	-	0.001	-	-	0.001

* Egyptian Organization of Standardization "EOS" (2005) S.E**= Standard error of the mean.

Additionally, it was mentioned that adding onions, pickles, tomatoes, pepper, and spices to Shawarma sandwiches may help to raise Pb and cd levels **(Gupta *et al.*, 2003)**. Moreover, cooking utensils could be a source of heavy metals in these sandwiches. The main sources of cadmium are atmospheric deposition and sewage sludge (**European commission, 1996)**. Along with boosting migration and concentration levels from pans to meat, retaining meat in aluminum pans for a longer period and adding tomatoes and citric acid during the cooking of chicken shawarma also help **(Amal, 2000)**. All heavy metal concentration means were noticeably different from one another, as products from Kafr Elzayat city had higher heavy metal concentration means than all other products. This outcome can be explained by the fact that Kafr Elzayat is home to numerous industries, including companies producing pesticides and fertilizers. Along with busy public parks and automobile pollution, there are also street vendors selling food.

Table (3) shows lead and cadmium concentrations in street vended foods (plant products). We can see that lead amounts were undetectable in street and laboratory samples in percentages of 20–40% and 6–70%, respectively. Additionally, cadmium amounts in 20–30% and 70%, respectively, of street and laboratory samples were not found. As for the lead and cadmium concentrations found in the remaining tests, we can remark that they were higher than allowed in all street foods (from Tanta and Kafr Elzayat cities) but were below allowed in laboratory items.

The mean cadmium values in Taamia and Koshary in laboratory products were 0.034 and 0.048 ppm, respectively. The Egyptian Organization of Standardization, or "EOS," discovered that they were below acceptable levels (2005). It was distinct from street food because the average cadmium contents in Taamia and Koshary in Tanta city products were 0.379 and 0.530 ppm, respectively, whereas they were 0.524 and 0.62 in Kafr Elzayat city products. They went beyond what was allowed in Egypt. The study's measurements of heavy metal concentrations were consistent with those from **Soliman *et al.* (2011) and EL-Tellawy *et al.* (2018).**

Higher results may be attributable to industrial discharges that were discovered in the Nile River without being treated; these discharges contain significant amounts of lead and cadmium. Additionally, the use of untreated municipal insecticides, fertilizers, and fertilizers may increase these metals in farming areas. Use excessive chemical input to produce bumper yields in underdeveloped nations.

They frequently choose cheap, readily synthesized, and patent-expired chemicals. The edible sections of plants, animals, and cattle contain these compounds. Low quantities of heavy metals may exist in agricultural soils, but plants may collect them over time **(Naeem *et al.*, 2009)**. The same was true for lead concentration, which was higher than allowed levels in Tanta and Kafr Elzayat cities but below the levels seen in laboratory items. All heavy metal concentration means were noticeably different from one another, as products from Kafr Elzayat city had higher heavy metal concentration means than all other products.

Table 3. The lead and cadmium concentrations (mg/kg) in samples of street food (plant products) compares with those found in laboratory goods. (n=10).

Items		Lead			Cadmium		
		Maximum Permissible Limit (mg/kg) *	**%**	**Mean values ± S.E ****	**Maximum Permissible Limit (mg/kg) ***	**%**	**Mean values ± S.E ****
Lab	**Taamia**	0.1	30	0.099±0.006c	0.05	30	0.034±0.06c
	Koshary	0.1	40	0.084±0.009c	0.05	30	0.048±0.004c
Tanta	**Taamia**	0.1	70	1.32±0.10b	0.05	70	0.379±0.07b
	Koshary	0.1	60	1.307±0.10b	0.05	70	0.530±0.08ab
Kafr Elzayat	**Taamia**	0.1	80	2.061±0.315a	0.05	80	0.524±0.06ab
	Koshary	0.1	80	1.65±0.11ab	0.05	80	0.62±0.064a
Significance		-	-	**0.001**	-	-	**0.001**

* Egyptian Organization of Standardization "EOS" (2005) S.E**= Standard error of the mean.

4. Conclusion

The current analysis established that the analyzed samples had high lead and cadmium contamination. As a result, regular eating of these tainted foods could put the public at risk for health problems due to the body's cumulative, irreversible accumulation of hazardous chemicals. A periodic inspection of foods sold on the streets must be carried out, with legislation and violations in place for violators. The public is advised to eat foods from high-quality and reliable places.

5. Conflict of Interest

I, the author of this paper, earnestly declare that there is no conflict of interest or relationship, financial or otherwise (between me and any individual, organization, or a group of people) that might be perceived as influencing my objectivity.

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