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El-Sayed M. Hammad
National Nutrition Institute

Fardous Soliman
National Nutrition Institute, fardous_soliman@hotmail.com

Hanaa Salah
National Nutrition Institute

Manal Mohammed
National Nutrition Institute

Mohamed Farag
National Nutrition Institute

See next page for additional authors

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Detection of artificial colors added to cooked faba beans (Ful medames) and microbial examination for samples obtained from street vendors in Egypt

Authors

El-Sayed M. Hammad, Fardous Soliman, Hanaa Salah, Manal Mohammed, Mohamed Farag, and Om H. Ahemad

Original Article

Detection of artificial colors added to cooked faba beans (Ful medames) and microbial examination for samples obtained from street vendors in Egypt

Fardous Soliman[a], El-Sayed M. Hammad[a], Mohamed Farag[b], Om H. Ahemad[b], Manal Mohammed[b], Hanaa Salah[b]

Departments of [a]Clinical Nutrition, [b]Food Safety, National Nutrition Institute, ElKasre ElEini St, Cairo, Egypt

Abstract

Background

Cooked dried beans are commonly consumed in many countries and are known in Egypt as Ful medames. Adding synthetic colors to keep the dishes more attractive may have toxic effects on the human body, as it may be unsafe to consume potentially microbial contaminated foods, especially when obtained from street vendors.

Aim

The aim of this study was to detect the types of artificial colors added to cooked faba bean (Ful medames) by street vendors in Egypt and highlight their health hazards and microbial hazards.

Materials and methods

A total of 100 convincing samples were collected from street vendors from four large Egyptian cities. The coloring agents were extracted and purified from samples using the hydrochloric acid extraction method followed by separation using ascending paper chromatography. Total bacterial counts, coliforms, *Bacillus cereus*, *Staphylococcus aureus*, and mold and yeast counts were used for microbial tests on 24 samples obtained from Cairo and Giza cities.

Findings

Artificial colors were detected in 46% of samples. From the total positive samples, sunset yellow, tartrazine, or both combined were identified in 26.1, 30.4, and 41.3%, respectively. Carmoisine was detected combined with tartrazine in only one sample. Giza and Cairo cities recorded the highest positive samples (64.3 and 42.9%, respectively), followed by Mansoura (10%). No added colors were detected in Mahala samples. Coliforms, mold, yeast, and bacillus were detected in most of the samples that were subjected to microbiological examination, whereas *S. aureus* was not found in any of the examined samples.

Conclusion

Overall, 46% of the examined samples from street vendors contained artificial colors, mainly tartrazine and sunset yellow, although the authorities of Egyptian standards do not allow any artificial additives to these types of food. Most positive samples were from more urban cities. Microbial contaminants found in the examined samples may be due to unhygienic approaches in such areas and lack of sanitary practices of street vendors. This also predisposes consumers to the risk of severe public health challenges.

Recommendations

The society should be made aware about the health hazards of the incessant usage of synthetic food colors. The public should be encouraged to add natural food coloring, such as carrots, through home cooking instead. Moreover, strict monitoring of street vendors for food safety regulation should be done by competent authorities.

Keywords: Artificial colors, carrot, microbial examination, faba bean

Correspondence to: Fardous Soliman, PhD,
Department of Clinical Nutrition, National Nutrition Institute,
Cairo - 11562, Egypt.
Tel: +20 122 340 9622; Fax: 02/ 23647476;
E-mail: fardous_soliman@hotmail.com

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Introduction

Broad beans are a traditional staple food throughout the Mediterranean Basin and the Middle East, as well as in India, Pakistan, and China [1]. Faba bean (*Vicia faba* L.) is characterized by high levels of complex carbohydrates, proteins, and dietary fibers, coupled with a low content of saturated fat and the presence of several bioactive polyphenol compounds [2].

The dish of faba beans in Egypt is known as Ful medames. It is considered a popular, inexpensive, and affordable food for most people, especially individuals who are forced to eat away from their homes, where such food becomes an integral part of their lifestyle. So, it is readily available everywhere and when required in all areas of Egypt [3,4]. Furthermore, such foods are produced under unhygienic conditions, especially when sold by street vendors, with no enforcement of sanitary practices among them. Mainly, the beans are sold on unequipped bean carts in front of streets and similar open places with exposure to further contamination from air, dusts, flies, and length time of holding periods until eaten, in addition to the use of nonproperly cleaned utensils, like dishes and spoons, plus bad personal hygiene of street vendors themselves [5,6]. So, such 'street-vended foods' are introduced under unsafe conditions [7]. These adverse circumstances lead to much microbial contamination [8,9]. Therefore, popular foods like faba bean are usually served with uncontrolled microbial quality [10] and may expose the consumers to health risks [11,12].

An attractive color of faba beans prepared outside homes, especially sold by street vendors, is often noticed, which is because of addition of some artificial colors. Artificial food colors make the foods attractive and stimulate appetite; however, in developing countries, there has been a marked increase in the use of synthetic food-coloring agents. In past years, there has been an uncontrolled use of synthetic color, particularly in food mostly consumed by children [13].

Only food additives that have undergone a Joint FAO/WHO Expert Committee on Food Additives (JECFA) safety assessment can be used. JECFA is an international scientific expert committee administered jointly by the Food and Agriculture Organization of the United Nations (FAO) and WHO. However, WHO encourages national authorities to monitor and ensure that food additives in food and drinks produced in their countries comply with permitted uses, conditions, and legislation [14].

The Egyptian Constitution for Food Standards [15] prohibits adding any artificial substances to unpacked pulses. Therefore, it was necessary to know the types of the added colors and to display their effects on health and suggest other natural healthy coloring sources.

Aim

The aim of this study was to detect types of artificial colors and microbial contaminants in cooked faba bean (Ful medames) in samples obtained from street vendors in Egypt and highlight their health hazards.

Materials and Methods

A total of 100 samples of fava beans were collected from street vendors from four large cities (Cairo, Giza, Mansoura, and Mahala) from December 15, 2019, to January 15, 2020. Acetic acid glacial, ammonia solution, isobutanol, and ethanol were purchased from El-Gomhoria Company, Cairo, Egypt. Synthetic food colors tartrazine, sunset yellow, and carmoisine were obtained from Kamina Co. for food products, Cairo, Egypt. A total of 24 samples from Cairo and Giza, which included six samples of faba bean at bean capacity directly and 18 samples after distributed in dishes, were examined for the total bacterial count, coliforms, *Bacillus cereus*, *Staphylococcus aureus*, and mold and yeast count according to ISMSF 1978 [16].

Accessories

Natural white wool, paper chromatography, glass capillary tubes, and jar and lid were used.

The extracted color concentrates were separated using ascending paper chromatography [17,18]. Whatman No. 1 filter paper (20 × 20 cm) was used. Extracts of colors as well as reference color compounds were spotted on the same paper using 10-µl capillary tubes. The spots were dried with blowing hot air using hair drier to avoid diffused spots. A 30-mm pore size paper was placed in a 2 litres containing about 50-ml solvent. Solvents were used separately. Distilled water, isobutanol, ammonia, and ethanol 5: 10: 8:5 (v/v) were poured into the chromatography jar to a depth of about 2 cm. Then, the paper chromatography was covered with a lid was extracted according to Farzianpour *et al.* [19].

The development was allowed until the solvent front had reached a height of 12 cm from the baseline. Then, the paper was removed and dried. The color and number of the separated spots were recorded, and the R_f value for each spot was calculated according to Rezaei *et al*. [20].

$$\mathrm{Rf} = \frac{\text{Distance travelleby the spot of the food colour}}{\text{Distance travelled by the solvent front}}$$

Results

Results presented in Table 1 and Fig. 1 revealed that one or more types of artificial color were detected in 46 of 100 samples

Table 1: Number and percentage of positive and negative samples in the four cities

Cities	Positive samples [*n* (%)]	Negative samples [*n* (%)]	Total number [*n* (%)]
Cairo	18 (42.9)	24 (57.1)	42 (100)
Giza	27 (64.3)	15 (35.7)	42 (100)
Mansoura	1 (10)	9 (90)	10 (100)
Mahala	0	6 (100)	6 (100)
Total	46 (46)	54 (54)	100 (100)

of cooked fava beans collected from four large Egyptian Cities. Giza showed the highest percentage of positive samples, where 27 (64.3%) of 42 samples were positive for artificial coloring. Of the 42 samples from Cairo, 18 (43%) samples were positive. Added artificial colors were detected in only one of the 10 samples collected from Mansoura (10%). However, the remaining six samples from Mahala City were free from added artificial colors.

Types of added colors are shown in Figs. 2 and 3. Of 46 positive samples, sunset yellow color (E110) was detected alone in six (33.3%) of the positive samples from Cairo and six (22.2%) of the positive samples from Giza. Tartrazine (E102) was detected alone in six (33.3%) of the positive samples from Cairo, seven (~30%) of the positive samples from Giza, and a lone positive sample from Mansoura. Both colors were found together in 27.8 and 51.9% of the positive samples in Cairo and Giza, respectively. Carmoisine (E122) combined with tartrazine was detected in only one sample from Cairo.

Regarding microbial examination, results of Table 2 showed that aerobic bacterial count ranged from negative to 8×10^3 cfu/g, coliform ranged from negative to 2 cfu/g, *B. cereus* ranged from negative to 5×10^2 cfu/g, and mold and yeast count ranged from negative to 2×10^4 cfu/g. *S. aureus* was not detected in any sample from Giza.

Table 3 shows that bacterial count ranged from 1×10^2 to 4×10^3 cfu/g, coliform ranged from negative to more than 110 cfu/g, *B. cereus* ranged from negative to 3×10^2 cfu/g, and mold and yeast count ranged from 1×10^2 to 1×10^4 cfu/g. *S. aureus* was not detected in any sample from Cairo.

From these results, it is clear that there is contamination in most samples, especially that are sold already in dishes, than those taken directly from bean capacity.

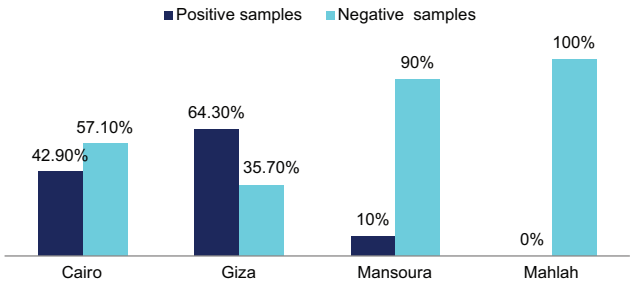

Figure 1: Percentage distribution of positive and negative samples in the four cities.

Discussion

In addition to their high nutritive value, being rich in protein, fibers, potassium, magnesium, folate, iron, zinc, and polyphenols [2], the intake of dietary pulses improves blood lipid profile, blood pressure, and inflammation biomarkers [21–23].

A commonly consumed cooked dried bean is so popular in Egypt that it can be considered an Egyptian National dish.

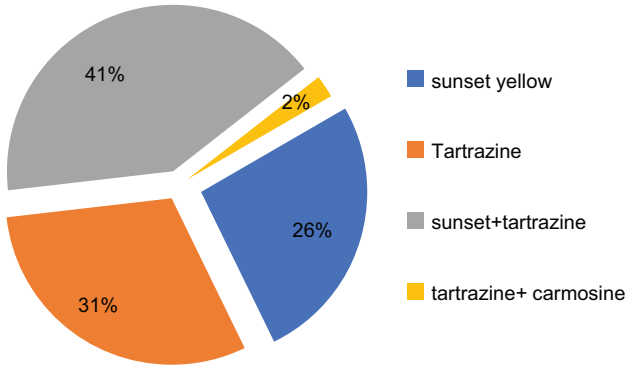

Figure 2: Percentage distribution of food colors in cooked fava bean.

Table 2: Mean microbial count in faba bean samples collected from Giza Governorate

Type of samples	Microbial count				
	Total bacterial count	Coliform	*Staphylococcus aureus*	*Bacillus cereus*	Mold and yeast
Bean capacity (from Quedra)	<10	<10	<10	<10	<10
From dishes	8×10^3	2	<10	5×10^2	2×10^4
From dishes	2×10^3	<10	<10	<10	1×10^3
From dishes	2×10^3	<10	<10	2×10^2	1×10^4

Number of samples: three samples from each.

Table 3: Mean microbial count in faba bean samples collected from Cairo Governorate

Type of samples	Microbial count				
	Total bacterial count	Coliform	*Staphylococcus aureus*	*Bacillus cereus*	Mold and yeast
Bean capacity (from Quedra)	1×10^2	<10	<10	<10	1×10^2
From dishes	1×10^2	<10	<10	<10	1×10^3
From dishes	6×10^2	>110	<10	3×10^2	1×10^2
From dishes	4×10^3	<10	<10	1×10^2	1×10^4

Number of samples: three samples from each.

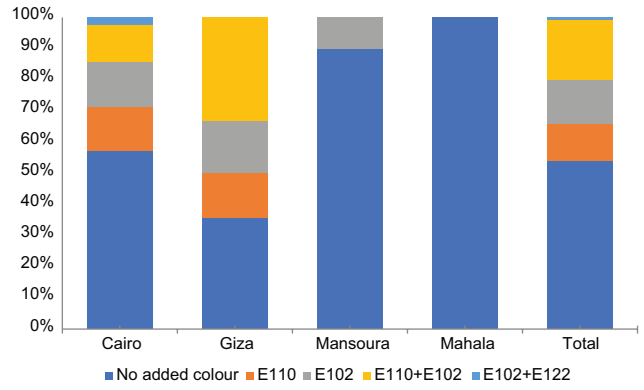

Figure 3: Samples distributed according to different types of artificial colors by cities. E110: sunset yellow. E102: tartrazine. E122: carmosine.

Although the Egyptian Constitution of Food Health and Safety Practices 2005/2006 does not permit any additives to be added to certain foods, including unpacked pulses, some street vendors add chemical colors to fava beans (Ful medames) for attraction.

In this study, 100 samples of faba beans (Ful medames) were collected from street vendors from four Egyptian cities. Artificial colors were detected in 46% of the examined samples, although they are prohibited by the Egyptian Constitution for Food Standards. Of the 46 positive samples, sunset yellow was detected alone in about a fourth of the positive samples, about a third contained tartrazine alone, whereas two artificial colors combined were detected in about 40% of the positive samples. Carmoisine was detected combined with tartrazine in only one sample. Samples from the more urban cities showed the highest percentage of artificial food colors compared with rural ones. This may be owing to less street vendors in rural areas and possible home preparing of Ful medames by some homekeepers.

A study conducted in Kashan City, Iran, examined 149 samples of sweets, drinks, and miscellaneous foods. Approximately 52% of examined foods contained artificial colors that have been banned by the national Iranian standards organization. The quinoline yellow, tartrazine, and sunset yellow were the most common coloring agents used in various foods [24].

Another study conducted in Jaffna district, Sri Lanka, on 110 samples of confectioneries and beverages, 100% beverages and 85% confectioneries contained permitted synthetic food colors. Overall, 8% of the confectioneries contained nonpermitted colors that do not comply with any of the permitted synthetic food colors [25].

According to our knowledge, this is the first published research to test for added artificial colors in consumed Ful medames in Egypt.

The detected artificial colors in this research are mainly sunset yellow (E110) and tartrazine (E102), which is in concordance with the results obtained from Karachi City, Pakistan [25] and Korea [26], where tartrazine and sunset yellow were also the most common colors used in various food products.

Tartrazine and sunset yellow although permitted by the European Union (EU) are known to have serious health hazards, especially if they are not subjected to the doses determined by the laws regulating additives by the international expert scientific group – the JECFA [27].

An excessive consumption of sunset yellow dye can cause attention-deficit hyperactivity disorder in children, in addition to cancer, asthma, and immunosuppression [28].

Tartrazine dye can cause food allergies, mutagenicity, carcinogenicity, and photo toxicity [29]. Cumulative indications have been increased, demonstrating the potential danger of tartrazine on liver, kidney function, lipid profile, oxidative stress biomarkers, nervous system, hyperactivity, and cancer [30]

Moreover, it was demonstrated by Sadar *et al*. [31], that toxic level of almost all food colors had inhibitory effects on normal flora and yeast.

Regarding microbial contamination, samples collected from Cairo and Giza governorates were examined for total bacterial count, coliforms, *B. cereus*, *S. aureus*, and mold and yeast count. These results showed that most samples were contaminated with microorganisms. All samples taken directly from bean capacity were free from microbial contamination in Giza samples. This may be owing to the high temperature of bean capacity along the time. However, there was low load of total bacterial count and mold and yeast in Cairo samples taken directly from bean capacity. This may be owing to poor personal hygiene during food processing, in acceptance with Fellows and Hilmi [32], who stated that poor personal hygiene during food processing is an additional predisposing factor for ready-to-eat food contamination during the process chain.

Moreover, cross-contamination may occur during distribution from food handlers, utensils, and added water. Good manufacture practices – including temperature – during serving and distribution were inadequate. On the contrary, all samples of faba beans taken from dishes were loaded with one or more microorganism in both Giza and Cairo samples. This may be owing to unhygienic conditions such that the risk of exposure to food contaminants is increased as report by Al Mamun *et al.* [33,34], and World Health Organization (WHO) [35]. Moreover, lack of sanitary practices applying within such areas especially when introduced on unequipped traditional bean carts in front of streets and similar open places exposed to further contaminants from air, dusts, flies, holding temperature, length time of holding periods until eaten, in addition to the using of uncleaned utensils like dishes and spoons [5,6]. Additionally, some bad personal behaviors of food handlers themselves may contribute in such contamination as reported by Fellows and Hilmi [32], who stated that poor hygiene

practices during and after food preparation and handling by vendors play a key role in contamination of ready-to-eat foods, and vendors often lack good hygiene practices. A common scenario is vendors not washing their hands, the washing of hands with no potable (contaminated and unsterilized) water, or use of potable water but without detergents or disinfectants before and during serving dishes. For instance, vendors commonly touch raw foods directly with unwashed hands during the postproduction slicing process. In addition, most vendors do not wear protective coverings. These results also go in harmony with Lindh and Lehane [36] who mentioned that vendors openly display the foods for sale in roadside make-shift sheds, which are sometimes situated close to dump sites or dirty stagnant, roadside water. These serve as reservoirs to flies and other insects that are potential carriers of several bacterial pathogens. Kassem [37], El-SayedAtef [38], and Kassem *et al*. [39] stated that handlers and utensils are beyond contamination during serving and distribution of dishes. Oluwadamilola *et al*. [40] reported that ready-to-eat foods were often vended in outdoor environments, such that they are exposed to several contaminants of microbial origin.

Implication

In an attempt to reduce the consumption of artificial colors, fortification of Ful medames with carrot as a natural coloring food will also increase its nutritive value as being rich in antioxidants and dietary fibers. To minimize bacterial contamination, strict control of the personal hygiene of street vendors and utensils used in serving is mandatory.

Conclusion and Recommendation

The excessive usage of food colors detected in cooked faba beans (Ful medames) by street vendors and the potential microbial load in such samples raise the following recommendations:

(1) Increase awareness of the population at different levels about health hazards of the incessant usage of artificial food colors.
(2) Encourage homemade preparation of commonly consumed foods suspected to have artificial colors.
(3) Encourage adding natural coloring substances that enhance the nutritional value and also act as an antioxidant, such as carrots.
(4) More attention to food safety regulations must be paid by observatory authorities for preventing risks and health hazards associated with such popular food like faba beans, especially that are produced under street conditions.
(5) Set legislation for global regulations on food safety and strictly monitor it by the competent authorities.
(6) Make sure that sanitary conditions and hygiene practices were fulfilled if enforced to eat outside.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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