

Evaluation of the chemical content and sensory properties of some ready-made potato chips products (Chips) available in the local markets in Brak Al Shati area

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تقييم المحتوى الكيميائي والخصائص الحسية لبعض منتجات رقائق البطاطس الجاهزة (الرقائق) المتوفرة في الأسواق المحلية بمنطقة براك الشاطئ

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Abstract:

Aims: This study was conducted to determination of concentration of some heavy metals in potato chips samples due to essential or toxic nature of this metals and due to increase consumption of potato chips especially by children. **Methods:** This study was conducted on 8 samples of the most widely consumed ready-made dry potato chips, in addition to the control sample (fried potato slices without any additives) collected from local markets in the Brak Al-Shati area. The concentrations of heavy metals in the most widely consumed ready-to-eat foods are considered to be higher than the permissible levels. 20 chemical elements were detected in potato chip samples: (potassium (K), calcium (Ca), silicon (Si), chlorine (Cl), aluminum (Al), phosphorus (P), nickel(Ni), sulfur(S), iron(Fe), manganese(Mn), copper(Cu), zinc(Zn), cadmium(Cd), barium(Br), silver(Ag), titanium(Ti), uranium (U), arsenic (As), chromium (Cr) and sodium (Na) including the control sample (0), were determined by: X-ray fluorescence analysis, **Results:** The study recorded presence of this heavy metals in all samples in different concentrations. The percentage of contamination with Cd was high in all samples and exceeded the permissible limit of 0.001 ppm as stated in EPA/US 2015, and a data evaluation was also conducted. Product packaging, sensory evaluation, and compliance with hardness specifications. **Conclusion:** The results showed that some samples contain these metals in a percentage above the permissible limit, this exposes consumers of these products to the risk of developing serious health problems

Keywords: : potato chips, heavy elements, pollution, ready -made food, product quality.

المخلص:

الأهداف: أجريت هذه الدراسة لتحديد تراكيز بعض المعادن الثقيلة في عينات رقائق البطاطس، وذلك نظرًا للطبيعة الأساسية أو السامة لهذه المعادن، وبسبب الزيادة الملحوظة في استهلاك رقائق البطاطس، خصوصًا بين الأطفال. **الطرق:** أجريت هذه الدراسة على ثماني عينات من رقائق البطاطس الجافة الجاهزة للأكل والأكثر استهلاكًا، إضافةً إلى عينة ضابطة متمثلة في شرائح بطاطس مقلية دون أي إضافات. جُمعت العينات من الأسواق المحلية في منطقة براك الشاطئ. وقد تم الكشف عن عشرين عنصرًا كيميائيًا في عينات رقائق البطاطس، بما في ذلك العينة الضابطة رقم (0)، وهي: البوتاسيوم (K)، الكالسيوم (Ca)، السيليكون (Si)، الكلور (Cl)، الألومنيوم (Al)، الفوسفور (P)، النيكل (Ni)، الكبريت (S)، الحديد (Fe)، المنغنيز (Mn)، النحاس (Cu)، الزنك (Zn)، الكاديوم (Cd)، الباريوم/البروم (Br)، الفضة (Ag)، التيتانيوم (Ti)، اليورانيوم (U)، الزرنيخ (As)، الكروم (Cr)، والصوديوم (Na). وقد تم تحديد تراكيز هذه العناصر باستخدام تقنية التحليل بالفلورية السينية (XRF).

النتائج: سجلت الدراسة وجود هذه المعادن الثقيلة في جميع العينات وبتراكيز متفاوتة. وقد أظهرت النتائج أن نسبة التلوث بالكاديوم (Cd) كانت مرتفعة في جميع العينات، وتجاوزت الحد المسموح به البالغ 0.001 ppm وفقاً لما ورد في معايير EPA/US 2015. كما أُجري تقييم للبيانات شمل تغليف المنتج، والتقييم الحسي، ومدى المطابقة لمواصفات الصلابة. **الخلاصة:** أظهرت النتائج أن بعض العينات تحتوي على تراكيز من هذه المعادن تتجاوز الحدود المسموح بها، الأمر الذي قد يعرض مستهلكي هذه المنتجات لخطر الإصابة بمشكلات صحية خطيرة.

الكلمات المفتاحية: رقائق البطاطس، العناصر الثقيلة، التلوث، الأطعمة الجاهزة، جودة المنتج.

1. Introduction

Chips are called snacks, and they are eaten between meals. They are a product of potato chips fried in oil, with natural or artificial flavors added to them. They contain a lot of added salts to enhance the flavour, in addition to the presence of many preservatives, fats and sugars. , which in many cases is not mentioned in the list of contents. Environmentally, chips bags do not decompose due to natural factors dissolved in the soil, which represents a danger to the environment and its various components, as it is one of the plastic wastes [1]. Food pollution is one of the environmental problems that has received great attention at the present time, due to its environmental and health effects on humans. Therefore, it has become necessary to study the causes of food pollution and its related negative consequences [2], the threat of foreign substances in food has elicited a strong response from researchers, and the discovery of the possibility of toxic substances in food continues to attract their attention. It has been found that contaminated raw materials are the main source of food contamination [3], which means that any unwanted substances or foreign bodies, such as heavy metals or microorganisms such as fungi, enter the food [4]. Food may become toxic as a result of the use of containers and packaging materials. Unsuitable or due to contamination from equipment in contact with it during manufacturing operations. Chips are considered a suitable environment for the growth of fungi and contamination with mycotoxins, the risks of which increase through the production of toxins that they secrete in foodstuffs, thus infecting humans with many diseases [5] and [6]. Adding minerals to foodstuffs is beneficial for the health of the body, but adding them in high concentrations may produce adverse results. Sodium and potassium are important nutrients for balancing fluids within the body's cells, and for maintaining the osmotic pressure in it. On the other hand, they are considered harmful to health if they exceed the permissible limit. Especially sodium, which is available in most meals. Heavy metals also have the ability to bioaccumulate and thus can lead to harmful effects on the human body [7]. Cadmium, lead, mercury, arsenic, aluminum and chromium are toxic elements even in minute concentrations [8]. In addition, heavy elements may lead to kidney failure, liver damage, nervous weakness, cardiovascular disease, cancer, and others [9], while the elements copper, iron, manganese, and zinc may perform vital functions in the body [10]. However, unfortunately, most of us do not know the benefits and harms of these foods at all, and perhaps the danger of eating chips lies in the process of adding a lot of salts, spices, artificial flavors and dyes, to enhance the flavor and act as flavor and smell enhancers, which are chemical additives that tempt people to ask for more and become addicted to them. In addition, not all ingredients are mentioned in the contents list. Environmentally speaking, chips bags do not decompose due to natural factors dissolved in the soil, which represents a danger to the environment and its various components because it is one of the plastic wastes. Lead has not been known to have a beneficial function in human metabolism until the present time and has been observed to be associated with many acute and chronic effects on organisms including humans. According to the Agency for Toxic Substances and Disease

Registry [11], some of the body systems affected by lead, arsenic, and mercury include the cardiovascular, digestive, nervous, renal, reproductive, and respiratory systems. Lead is gonadotoxic and fetotoxic due to its ability to cross the placental barrier. Arsenic is of little danger to the human consumer due to its low concentration in meat (muscle). Chronic poisoning leads to the degeneration of the kidneys and liver. Cadmium is used in the manufacture of pesticides, dyes, and ceramic coatings, and it accumulates in the liver and kidneys. Discharge of industrial waste into bodies of water leads to the accumulation of this toxic element in fish, then it is transmitted to humans, causing kidney failure. It also affects the blood and bone growth. Copper (Cu) If food is contaminated with this element, it leads to chronic poisoning, which in turn causes enlargement of the kidneys and liver and bloody urine [12]. Common heavy metals such as cadmium and lead are cumulative toxins capable of causing environmental hazards and are said to be toxic if ingested in excess. [13] However, metals such as iron and zinc are considered essential materials for humans, as they play an important role in ecosystems [14]. In a study conducted by [15] he showed that the rate of consumption of processed foods in low- and middle-income countries has become even faster than it was in high-income countries, based on this shift. [16] conducted a study to determine the levels of some elements (sodium, potassium And calcium) in addition to heavy elements (iron, lead, and cadmium), in some brands of potatoes and corn selected from the local market of the city of Hilla in Iraq, and collected in October 2013. The results showed that the average elements in potato chips were as follows: 5330, 2125, 60, and 1 .59, 7.73, and 0.43 mg/kg in potato brands, and 2270, 6650, 465, and 4.40, 11.86, and 0.266 mg/kg in corn flakes for sodium, potassium, calcium, iron, lead, and cadmium, respectively.

2- Materials and Methods:

Sample collection and preparation:

Types of potato chips traded in shops in the city of Brak Al-Shati were chosen, and a number of types that were common and preferred by consumers were chosen, taking into account the choice of different types and country of manufacture. 8 samples were included: Chipsy, BZIADA, Mahboul, Doritos, Lays, Pattes, Pringles, Tiger, with one sample without additives (control). The samples were transported to the laboratory, each sample was ground separately and stored in clean bottles and a weight of 4 grams was taken for each sample to estimate its elements.

X-ray fluorescence analysis device

This phenomenon can be used to identify the components of some materials [18]. The total concentration of some elements in the chip samples was determined using the X-ray fluorescence technique using an X-ray tube system, where secondary targets Ti-Cu-Mo were used to excite the X-rays by Radiation survey, model new QC+ Quant CZ, 2017. The following table shows the operating conditions for the f-x-ray technique to determine the chemical elements. The simple analysis method (the sensitivity curve method) was used to determine the elements after drawing the sensitivity curve, and it was estimated in a unit (ppm/cps).

Table (1) Operating conditions using x-ray f

Secondary goal	Analyzed elements	Operating conditions
Ti-S-Cl	1000sec	20 ma 25kv
Cu-K-Ca-Ti-Mn	1000sec	10 ma 30kv
Mo-Fe-Ni-Cu-Zn-Br-Rb-Sr-Pb	1000sec	5 ma 40kv

Evaluation of packaging data for potato chips products

An information card was created for the entire studied samples, by revealing all the external data of the packages and comparing them with the label of the food product information card, to ensure the quality of the bags and their compliance with the Egyptian Standard Specification M.C. No. 1546, according to what was mentioned in the Libyan Standard Specification [23]. And Egyptian [17].

Sensory tests:

The sensory test was performed according to the method [19].

- Color was evaluated according to the marks mentioned in the comparison cards as follows: (1) white, (2) pale yellow, (3) golden yellow, (4) dark yellow with a slight brown tint (at the edges), (5) reddish yellow. With clear brown edges, (6) reddish color with clear brown discoloration, (7) brown discoloration covering the surface of the chips.
- Texture:- (1) very hard, (2) tough, (3) somewhat soft (slightly hard), (4) soft, (5) very soft.
- Taste (flavor): (1) excellent, (2) very good, (3) good, (4) acceptable, (5) unacceptable.

3- Results and discussion:

Estimation of chemical elements

Twenty chemical elements were detected in various potato chip samples, as shown in Table (2) below. It was found that all samples contained thirteen chemical elements, namely: K, Ca, Si, Cl, Al, P, Ni, S, Fe, Cu, Zn, Cd, and Br, respectively, including the control sample. The most abundant element was potassium, K, and the least was As. Sample No. (3) was the most polluted sample with heavy elements. The concentration of K ranged between (123.255-30.25ppm), and it was the highest. Concentration in sample (6) and the lowest concentration in sample (7), which is the element with the highest concentration in all samples, as it was recorded at a concentration of 123.25 ppm, while the concentration of Ca was from 21-60.75 ppm, and this result for Ca was consistent with what was mentioned by [16]. All samples contained Si at concentrations of 18.65 - 78.75 ppm. While the concentration of Cl in all samples, the highest in sample (2) was 108.5 ppm, sample (7) recorded the highest concentration in contamination with Al element at 12.87 ppm, the concentration of P element in all samples ranged from 5.82-11.25 ppm, Ni element concentration ranged from 2.87-9.15 ppm, and the concentration of S was from 2.38-13.22 ppm. The concentration of Fe ranged from 2.27 ppm in sample (3) to 18.32 ppm in sample (5). These percentages are considered high in all samples. This may be due to saturation of the soil with this element or By increasing its concentration during manufacturing due to its transfer from the tools and materials used, compared to the standard specifications of the US Environmental Protection Agency [20], These percentages were also higher than what was mentioned by [16]. The lower concentration of both the elements Mn and Zn was higher than the permissible limit. Also, in both Cu and Cd, the concentration was higher than what was recommended by [20]. The Cd element is considered high. In all samples there is an indicator of danger to human health. Br element was recorded at concentrations of 0.08-0.44 ppm in all samples, Ag element was (0.02-0.04 ppm), the highest concentration in 0 and 5 and the lowest concentration in 8 and 2, while it was not found in the other samples.

Table (2): Concentrations of chemical elements in potato chips samples (ppm).

samples Chemical elements	0 Control	1	2	3	4	5	6	7	8	limit allowed in the standard
K	119.75	95.75	49	100.75	41	104.75	123.25	30.25	93.5	180 mg ¹
Ca	31.5	23.52	31.75	21	35	29	37.75	60.75	56	600 mg ¹
Si	22.47	29.75	23.5	18.65	43.5	29.25	21.67	78.75	26.5	
Cl		20.95	108.5	27	41.25	35.75	24.72	19.05	23.67	38 mg ¹
Al	36	11.37	8.6	6.5	10.65	4.95	9.2	12.87	10.87	
P	9.27	5.82	7.22	7.15	9.82	6.12	6.95	11.25	9.72	9 mg ¹
Ni	5.82	3.17	6.07	2.87	3.4	6.42	7.12	5.22	9.15	
S	2.38	5.45	8.07	6.75	7.25	6.77	7.05	13.22	7.25	
Fe	3.97	2.42	3.95	2.27	2.95	18.32	4.42	7.77	5.03	10 mg ¹ -0.7ppm ²
Mn	-	1.13	-	1.25	1.31	2.17	2.11	1.95	2.82	0.07ppm ³
Cu	1.82	0.96	1.63	0.95	0.97	1.88	2.13	1.56	2.62	0.6 mg ¹ -0.04 ppm ²
Zn	1.25	0.6	1.06	0.58	0.85	1.39	1.96	1.08	1.75	5 mg ¹ - 0.3ppm ³
Cd	0.47	0.25	0.46	0.23	0.24	0.59	0.62	0.43	0.44	0.001ppm ²
Br	0.28	0.09	0.19	0.08	0.10	0.15	0.16	0.14	0.44	
Ag	0.04	-	0.02	-	-	0.04	-	0.03	0.02	
Ti	-	-	-	-	-	-	-	2.34	-	
U	-	1.00	-	0.88	-	2.31	1.35	-	-	
As	-	-	-	0.05	-	-	-	-	-	0.3ppm ⁴
Cr	-	-	-	1.25	-	-	-	-	-	
Na	-	47.75	-	51.75	51.75	-	-	-	-	3mg/day ⁵

Libyan standard¹, EPA/US, 2015², ATSDR, 2013³, SFDA/FD, 2019⁴ & WHO/2011⁵

The Ag element was the lowest in some samples (0.02-0.04 ppm), while it was not detected in samples 1, 3, 4, and 6. As for the element Ti, it was found at a concentration of 2.34 ppm in one sample. The element As and Cr were found only in sample 3. The results indicate a relatively high concentration of chemical elements that exceeds the standards [21]. Pollution may result from manufacturing and production processes, as well as when transporting the crop, the process of planting it in the field, and the type of irrigation water used. This exposes consumers to the risk of disease and ill health. It was concluded that sample 3 was the most contaminated species. Slightly high levels of nutrients are not a scary thing, as they are considered among the nutrients that the body needs, but their elevation above the permissible limit exposes the body to health problems, as the Na percentage was higher than the permissible limit, as recommended [22]. A slight increase in the levels of nutrients is not a scary thing, as they are considered among the macro- and micro-nutrients that the body needs, such as Ca, K, Fe, Zn, and Cu. The concentrations of these elements were less than the permissible limit in the Libyan standard [23], except for Fe, which was higher. The

percentage of 18.32ppm in sample (6) may be high as a result of the sample's components of additives

Potato chips packaging data:

The product is packed in suitable, clean containers that prevent moisture and water vapor from escaping, and are tightly packed to preserve their contents, and that they are similar in type and size and conform to the Egyptian standard specifications for the general requirements for plastic containers used in packing foodstuffs. What is stated in the Egyptian standard specifications for data on labels of packaged food products is taken into account. The data for the products studied were recorded in Table (3) as follows:

Table (3): Potato chip packaging data

Sampels	1	2	3	4	5	6	7	8
Data								
product name	Sweet barbecue	Pizza flavour	Table Salt	sweet spicy	Buttermilk potatoes and herbs	Marinated cheese	ketchup	Classic natural flavour
Type name	Chipsy	Pringles	Lays	Doritos	Pattes	Tiger	Bziada	Mahabool
Components	Fresh potatoes, vegetable oil, flavoring BBQ with honey Contains wheat and its derivatives.	Corn, vegetable oil, salt, pizza flavour	Fresh potatoes, vegetable oil, table salt	Corn, vegetable oil, sweet pepper flavoring, table salt, contains wheat (gluten)	Potatoes, palm oil, salt, whey, garlic, lactose, sugar, flavoring agent (e621a, e635), dill, dried parsley, mint, acidity regulator (citric acid), buttermilk powder, skim milk powder, malic acid	Fresh potatoes, vegetable oil, spiced cheese taste, contains wheat, milk and their derivatives	Potatoes, vegetable oil, ketchup taste, salt	Potatoes, vegetable oil, salt
Net weight	80g	100g	80g	74.84g	100g	75.80g	80g	100g
Production data	15.11.2021	16.9.2021	26.7.2021	6.11.2021	14.3.2021	19.9.2021	15.12.2021	9.8.2021
Expiration	15.5.2022	10.6.2022	26.4.2022	5.5.2022	14.3.2022	18.3.2022	14.6.2022	7.2.2022
Storage and handling requirements	Store in a cool, dry place away from sunlight	Store in a cool, dry place away from sunlight	Store in a cool, dry place away from sunlight	Store in a cool, dry place away from sunlight	Store in a cool place away from heat, moisture and sunlight	Keep away from heat and sunlight	Keep away from heat and sunlight	Keep away from heat and sunlight
Manufacturing country	Made in Egypt	Made in Italy	Made in Egypt	Made in Egypt	made in Türkiye	Made in Egypt	Made in Egypt	Made in Algeria
Importer's name and Country of origin upon import	-	-	Al Tasnim Food Import Company, Tripoli, Libya	-	-	-	-	-

In Table (3), it was noted that the name of the importing party was not mentioned on the packaging of chips products, with the exception of sample No. 3 (Al-Tasnim Foodstuff Import Company, Tripoli, Libya), as it conforms to the Libyan [23] and Egyptian [17] standard specifications for general requirements for plastic containers used in Food packaging. The absence of the name of the importing company indicates that these products entered in other ways without supervision or inspection, which exposes this product to adulteration by any unlicensed manufacturer that is not subject to established standards.

Sensory tests:

Shown in Table (4) that all samples had a desirable colour, texture and taste, except for sample No. (6) which had an unpleasant taste. The color of the control sample changed over time, becoming darker due to the oxidation of ferricloric acid. The intensity and amount of color depended on the ratio between This acid and citric acid are in the potatoes, and this does not affect their composition or suitability, and also their taste is the better.

Table (4) Results of sensory tests on potato chips samples

Sampels / Property	0 Control	1	2	3	4	5	6	7	8
Color	3	4	3	2	3	2	4	3	3
Texture	3	2	1	2	1	2	3	3	2
Taste	1	2	2	2	3	2	4	3	3

4- Conclusions:

The results indicated a relative increase in the concentration of some polluting chemical elements, especially Cd, exceeding the standards and specifications. Pollution may result from manufacturing and production processes, as well as when transporting the crop, the process of growing it in the field, the type of irrigation water used, or pesticides and chemical fertilizers. This exposes consumers to the risk of contracting diseases and ill health by increasing the consumption of these ready-made products. Most manufacturers neglect to write the name of the importer and country of origin in Import status that exceeds generally accepted standards.

5- Recommendations:

- 1- The use of hydrogenated vegetable oils in frying potatoes leads to the presence of large amounts of fat, which raises harmful cholesterol in the body. Obesity has also become an epidemic that is spreading in a frightening manner.
- 2- The consumption of ready-made potatoes must be reduced because bags of chips do not decompose due to natural factors in the soil, which poses a threat to the environment. Plastic waste is considered one of the most dangerous environmental problems at the present time, and it is preferable to choose environmentally friendly packaging.
- 3- Intensifying the process of monitoring chips factories and ensuring that they follow local and international recommendations and standards.
- 4- Children's food is the responsibility of the parents. Alternatives such as popcorn or making chips at home free of additives must be provided for these snacks that are harmful to children's health and cause several diseases such as stomach diseases, bedwetting, delayed growth, and imbecility.
- 5- Raising health awareness among all segments of society, and warning of the dangers of the recent increase in consumption of snacks.

6- The level of contamination with chemical elements may exceed the permissible limits according to standards and specifications, and this is a dangerous indicator of the accumulation of these elements in the human body.

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