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STUDIES ON SOME CHEMICAL POLLUTANTS IN SOME FOOD PRODUCTS
ACRYLAMIDE CONTENT AND HEAVY METALS IN SOME BAKERY AND DRIED FRUITS PRODUCTS .

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ABSTRACT

Ac*rylamide is formed mainly in carbohydrate-rich foods during the Millard reaction between reducing carbohydrates and amino acid . The harmful effects of acrylamide on human health were discovered in 2002 by a group of Swedish researchers. Sixty samples of dried fruits and one hundred and fifty samples of bakery products were collected in different places in Sharkia Governorate, Egypt to investigate the acrylamide and heavy metals content to know the extent to which these foods comply with the terms of food conformity.*

Data representing the acrylamide content showed a great variation among different types of food samples depending on the chemical composition and processing parameters. The acrylamide values were 645, 1032, 833 and 769 ug/kg for dried peach, dried figs, raisins and dried dates; respectively. Meanwhile, the bakery products (biscuits) had 289 – 333 ug / kg of acrylamide. Some bread samples had a (335 – 340 ug/kg) of acrylamide .

On the other hand, pizza products had the highest value (1123 ug/kg) of acrylamide. Heavy metals (Lead , Cobalt , Mercury and Nickel) content were below detection limit in all tested samples .

Conclusively, t*he content of acrylamide and heavy metals in the studied samples of bakery products and dried fruits was within the food safe limits compatible with FDA requirements , except for pizza , which had a high level of acrylamide*

Keywords: Acrylamide; Dried Fruit; Bakery products

INTRODUCTION:

The harmful effects of acrylamide on human health were discovered in 2002 by a group of Swedish researchers at the University of Stockholm, together with specialists from the Swedish National Food Administration,

who sounded the alarm after finding that the population, through food, ingests a much higher amount of acrylamide (AA) than the maximum limit allowed at that time in drinking water (**Jeong *et al*., 2020; Rifai *et al.*, 2020)**. Acrylamide has been described to present neurotoxic, genotoxic, carcinogenic and reproductive toxic effects (**Rice *et al.*, 2005**).The major mechanism for the formation of acrylamide during cooking is now acknowledged to be the reaction of the free amino acid asparagine with reducing sugars, such as glucose or fructose, during the Maillard browning reactions that occur during cooking at high temperatures. Several factors will affect the acrylamide content in each product such as food composition, pH, water activity, and technological conditions during baking process **(Claus *et al.*, 2008).** Acrylamide is formed mainly in carbohydrate-rich foods, during the Maillard reaction between reducing carbohydrates (glucose, fructose, etc.) and amino acids (especially asparagine), a reaction responsible for the formation of specific taste and color (browning/ frying) **(Mesías *et al.*, 2019 ; Mousavi Khaneghah *et al.*, 2020**).

Therefore the aim of study was to investigate acrylamide content and evaluate the carbohydrate high products such as dried fruits and bakeries products to matches the FAO / WHO recommendation.

MATERIALS AND METHODS

Sampling :

Sixty (60) samples of dried fruit were collected from different sites in Sharkia Governorate, Egypt during season 2021. One hundred fifty (150) samples of bakery products were collected from Zagazig , Belbeis and Dearp Negm bakeries , Sharkia Governorate , Egypt.

Methods :

Chemical analysis**;** moisture, protein, fat, ash, and fiber were determined in the Central Laboratory for Soil, Foods and Feedstuffs (International Accredited Lab, has ISO 17025 since 2012), Faculty of Technology & Development, Zagazig University, Zagazig, Egypt.

Chemical analysis for food ingredients (ISO). Moisture content was determined according to ISO 6496: 1999, ash according to ISO 5984:2002 and crude Protein according to ISO 5983-1:2002. crude fat and crude Fiber were determined according to the methods described in Official Journal of the European Union (EN),2009, L54 / 37 and 40**;** respectively Volume 52 . Carbohydrate was calculated by difference.

Heavy metals**;** copper, lead, cobalt, mercury and nickel were determined in Atomic Absorption Spectrophotometer manufacturer Perkin Elmer 2380, according **(Darko and Voegborlo, 2014).**

Acrylamide content was estimated in High Institute of Public Health Department of Nutrition, Alexandria Univ, using High-performance Liquid chromatography (HPLC) according to **(Gokmenv and Senyuva, 2006) .**

RESULTS AND DISCUSSION

Dried fruits such as peach, figs, raisins and dried dates have been popularly used in Holly Ramadan in many countries around the world because of their nutritional value and effectiveness. In addition, they contain water, calcium, iron, cooper and many vitamins which protect, maintain health and treat various diseases. Table (1) shows the chemical analysis of these dried fruits. The mean values of moisture content were 29.54, 20.2, 21.17 and 12.99 for peach, dried fig, raisins and dried dates; respectively. The carbohydrates contents were 60.3, 56.49, 67.00 and 63.53 %; respectively. While the protein content ranged between 2.94 to 4.82 %; fat content ranged between 2.12 % to 8.43 %, the highest value of fat was found in dried dates.

The ash contents were 1.45, 2.64, 2.42 and 4.57 % for peach, dried figs, raisins and dried dates; respectively. Meanwhile, the fibers content ranged between 3.07 % to 12.29 %; the highest value was found in dried figs. Our results are in line with findings of (**Cvetkovic *et al.*, 2009; Ramadan *et al.*, 2016; and Terulel – Andreu *et al.*, 2021).**

Table (2) shows the concentration of heavy metals and acrylamide content in selected dried fruits. Lead, cobalt, mercury and nickel were investigated in some dried fruits such as peach, dried figs, raisins and dried dates. Lead, cobalt, mercury and nickel contents were below the detection limit using of Atomic Absorption Spectrophotometer. The results in Table (2) show that Iron contents were 29.5, 43.1, 54.0 and 65.3 ppm in peach, dried fig, raisins and dried dates; respectively. The highest value (65.3 ug/kg) for Fe++ was registered in dried dates while the lowest value was found in Peach. This means that the use of these products meets the daily needs of the body, as most nutrition references indicate that the body needs 8-16 mg of iron per day (**Seddigi *et al.*, 2016)**. The Cu++ contents as microgram per g. were 5.48, 4.48, 5.71 and 6.43 for peach, dried fig, raisins and dried dates; respectively. Copper is a micronutrient for energy utilization, brain function (neurotransmitter regulation), soft tissue and bone (collages synthesis), nutrient metabolism (especially iron) and antioxidant defence against free radicals **(VKM Report 2017: 19; C.F Strand *et al.*, 2018)**. The **WHO (2003)** recommended that the body needs 2 milligrams of copper per day. However, most fruits contain the amount of copper which is inadequate for normal growth **(Sobukola *et al* ., 2010) .**

Table (1): Chemical analysis of tested dried fruits

Dried fruit	No. of samples	Moisture %	*Carbohydrates %	Protein %	Fat %	% Ash	Fiber %
		Mean± SE	Mean	Mean± SE	Mean± SE	Mean± SE	Mean± SE
Peach	15	29.54±0.53	60.33	2.94±0.11	2.12±0.06	1.45±0.01	3.62±0.27
Dried figs	15	20.20±0.36	56.49	4.82±0.18	3.26±0.09	2.64±0.03	12.29±0.92
Raisins	15	21.17±0.36	67.00	3.44±0.13	2.90±0.08	2.42±0.02	3.07±0.23
Dried dates	15	12.99±0.23	63.53	3.20±0.12	8.43±0.24	4.57±0.05	7.28±0.54

* Calculated by difference SE: Standard error

Table (2): Heavy metals and acrylamide of tested dried fruits

Dried fruit	No. of samples	Iron (Fe) ppm	Copper (Cu) ppm	Lead(Pb) ppm	Cobalt (Co) ppm	Mercury (Hg) ppm	Nickel (N) ppm	Acrylamide (ug/kg)
		Mean± SE	Mean± SE					
Peach	15	295± 1.47	5.48±0.03	Nil	Nil	Nil	Nil	645
Dried figs	15	43.1± 1.00	4.48±0.02	Nil	Nil	Nil	Nil	1032
Raisins	15	54.0± 1.32	5.71±0.03	Nil	Nil	Nil	Nil	833
Dried dates	15	65.3 ±1.64	6.43±0.03	Nil	Nil	Nil	Nil	769

Nil : Below detection limit SE: Standard error

Heavy metals affect the nutritive values and also have deleterious effect on human beings. For that reason, national and international regulations on food quality set the maximum permissible levels of toxic metals in human food **(Sobukola *et al.*, 2010).**

At room temperature, water has been frequently used to extract acrylamide, which is a good hydrophilic small molecule and this also minimizes the dissolution of hydrophobic compounds in the food products. **Habermann (1991)** estimated the solubility of acrylamide in different solvents. He noticed that solubility in water of ethanol and acetone was 215.5, 86.5 and 63.1 g /100 ml: respectively. In some high carbohydrate-rich dried fruits in our study 60 samples of peach, dried figs, raisins and dried dates were analysed for acrylamide content The highest value was found in dried figs (1032 ug / kg) while the Lowest value was 645 ug / kg in case of peach samples. These results were within the ranges reported by some European countries and the USA in the **FAO / WHO** consultation meeting in **June 2002.** Therefore, these values pose a threat to human health.

One hundred fifty samples of bakery products were analysed for chemical composition, heavy metals and acrylamide contents **(Tables 3 & 4).** The samples were collected in three different places in Sharkia Governorate, Egypt. Moisture content from these samples ranged between 6.68 to 22.0 %; the lowest values were found in biscuits and chips bread while the highest values were noticed in pizza and vanilla cake 20.5 and 22.0 %; respectively.

Carbohydrates contents in tested bakery products ranged between 52.11 % to 69.8%; the lowest values were in toasted bread. The protein content ranged between 7.38 % - 13.5 %; while the fat content in these products ranged from 7.6 to 22.2%, Donuts had the lowest value of fat content (7.6 %) while biscuits had 22.2 % fat content. Ash and fiber content in bakery products was also determined (Table 3). Heavy metals and acrylamide content in bakery products were illustrated in (Table 4). Iron and copper are essential micronutrient which function as a biocatalysts for body pigmentation, maintain a healthy central nervous system and prevents anaemia **(Akindele and Osibanjo, 1982**) . Recommended daily intake (RDI) For Fe was 8-16 mg / day; while the copper in 73.0 p.p.m / **kg−1** b.wt . / day. Iron content in bakery products were higher than RDI; Meanwhile, copper content were below the RDI.

Table (3) Chemical analysis of Bakery products

Bakery products	No. of samples	Moisture	Carbohydrates	Protein	Fat	Ash	Fiber
		Mean± SE	Mean	Mean± SE	Mean± SE	Mean± SE	Mean± SE
Biscuits 1	15	10.10±0.18	65.55	8.00 ±0.31	14.42±0.41	0.61±0.01	1.32±0.10
Biscuits 2	15	11.70±0.21	55.8	7.38 ±0.28	22.22±0.63	0.76±0.01	2.14±0.16
Biscuits 3	15	6.68±0.12	62.3	9.38 ±0.36	19.68±0.56	0.64±0.01	1.32±0.10
Toasted Bread 1	15	29.53±0.53	39.8	19.76±0.76	4.32±0.12	3.52±0.03	3.07±0.23
Chipsy Bread 2	15	7.34±0.13	56.78	13.08±0.50	18.62±0.53	1.90±0.02	2.28±0.17
Chipsy Bread 3	15	8.61±0.16	56.66	10.21±0.39	21.30±0.61	1.02±0.01	2.20±0.16
Pizza 3	15	20.5 ±18	55.14	17.3 ±0.20	14.6 ±0.2	0.98±0.01	1.76±0.13
Vanilla cake 3	15	22.0 ±17	52.11	13.5 ±0.20	12.5 ±0.2	1.30±0.01	2.81±0.08
Cheese croissant 1	15	15.0 ±17	37.7	10.3 ±0.20	8.5 ±0.1	1.70±0.01	2.2±0.19
Donuts 2	15	17.5 ±23	39.5	10.5 ±0.20	7.6 ±0.5	1.40±0.01	2.5±0.10

1- From Deyarp negm bakeries, 2- From Belbeis bakeries , 3- From Zagazig bakeries ,are cities from Sharkia Governorate, Egypt .
SE: Standard error

Table (4): Heavy metals and acrylamide of Bakery products

Bakery products	No. of samples	Iron (Fe) ppm	Copper (Cu) ppm	Lead (Pb) ppm	Cobalt (Co) ppm	Mercury (Hg) ppm	Nickel (Ni) ppm	Acrylamide (ug/kg)	Upper limt* of acrylamide
		Mean± SE	Mean± SE						
Biscuits 1	15	9.7±0.4	4.04±0.02	Nil	Nil	Nil	Nil	332	650
Biscuits 2	15	8.5±0.3	3.50±0.02	Nil	Nil	Nil	Nil	289	650
Biscuits 3	15	9.2±1.3	4.5±0.02	Nil	Nil	Nil	Nil	333	650
Toasted Bread 1	15	36.5±1.4	2.69±0.01	Nil	Nil	Nil	Nil	339	1430
Chipsy Bread 2	15	24.1±0.5	3.68±0.02	Nil	Nil	Nil	Nil	340	1900
Chipsy Bread 3	15	17.8±1.3	4.88±0.02	Nil	Nil	Nil	Nil	335	1900
Pizza 3	15	13.5±0.3	2.52±0.03	Nil	Nil	Nil	Nil	1123	1490
Vanilla cake 3	15	43.0±1.5	2.68±0.02	Nil	Nil	Nil	Nil	298	363
Cheese croissant 1	15	32.5±1.5	3.12±0.01	Nil	Nil	Nil	Nil	408	476
Donuts 2	15	17.8±1.2	4.17±0.02	Nil	Nil	Nil	Nil	532	590

1- From Deyarp negm bakeries, 2- From Belbeis bakeries, 3- From Zagazig bakeries, are cities from Sharkia Governorate, Egypt.

*Recommended Daily intake (RDI) in Fe : 8 – 18 mg / day, Cooper is 1.0 ppm, Lead is 0.1 ppm, Cobalt is 0.05 ppm, Mercury is 0.0 ppm, and Nickel 0.05 ppm / kg b.wt / day according to Codex Alimentarius Commission, 2003 and FAO / WHO (2003).

SE: Standard error

Lead, cobalt, mercury and nickel content in tested bakery products were below the detection limit (Divrikli **et al; 2006**). Acrylamide content (ug / kg) in biscuits samples (289 – 333 ug / kg) while the upper limit was 650 ug / kg . Also, the bread content acrylamide content (335 – 340) these values were below the upper limit (1900 ug / kg). Only the Pizza products had the highest value of acrylamide (1123 ug / kg) this may be the high value of protein and carbohydrate content , baking temperature (180 ◦C) and baking time (15 min) . In general acrylamide content in tested bakery products were less than **FAO / WHO (2003**) recommendations.

In general the results concluded that , bakery products (biscuits) had a 289 – 333 ug/ kg of AA , bread samples had a 335 – 340 ug / kg of AA . and pizza had the highest value (1123 ug / kg) of acrylamide.

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دراسات على بعض الملوثات الكيماوية في بعض منتجات الأغذيه
1- محتوى مادة الأكريلاميد والمعادن الثقيلة في بعض منتجات المخابز والفواكه المجففة

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تتشكل مادة الأكريلاميد بشكل أساسي في الأطعمة الغنية بالكربوهيدرات أثناء تفاعل ميلارد الذى يتم بين الكربوهيدرات والأحماض الأمينية . تم اكتشاف التأثير الضار لمادة الأكريلاميد على صحة الإنسان في عام 2002 من قبل مجموعة من الباحثين السويديين.في هذا البحث جمعت ستون عينة من الفواكه المجففة ومائة وخمسون عينة من منتجات المخابز من أماكن مختلفة بمحافظة الشرقية ، مصر. لفحص محتوها من مادة الأكريلاميد والمعادن الثقيلة لمعرفة مدى توافق هذه الأطعمة مع شروط المطابقة الغذائية. أظهرت البيانات المتحصل عليها تباينا كبيرا فى محتوى الأكريلاميد بين الاغذيه المختلفه وذلك حسب التركيب الكيميائى والمعاملات التصنيعيه حيث كانت قيمة .مادة الأكريلاميد 645 و 1032 و 833 و 769 ميكروجرام / كجم للخوخ المجفف والتين المجفف والزبيب والتمور المجففة. على التوالى . بينما كانت منتجات المخبوزات (البسكويت) تحتوي على 289 - 333 ميكروجرام / كجم من مادة الأكريلاميد 0 بينما عينات الخبز تحتوي على (335 - 340 ميكروجرام / كجم) من مادة الأكريلاميد. وعلى الجانب الاخر ، كانت لمنتجات البيتزا أعلى قيمة (1123 ميكروجرام / كجم) من مادة الأكريلاميد .

التوصية : ان محتوى الاكريلاميد والمعادن الثقيله فى العينات المدروسه من منتجات المخابز والفاكهه المجففه كان فى الحدود الآمنه غذائيا والمتوافقه مع متطلبات FDA فيماعدا منتج البيتزا الذى كان يحتوى على مستوى عالى من الأكريلاميد .