RECOMMENDATIONS

1. Protection is better than treatment so cereals storage must be under healthy conditions of temperature, moisture, away from insects and birds, and not stored for a long period of time than few months in order to avoid formation and spread of fungal secondary metabolities.

2. Buy seeds from Known, reliable, sources where you know it is fresh clean and has been handled properly.

3. It is not recommended to add maize to wheat in Egyptian bread production since it may increase the daily intake of aflatoxin B_1.

4. The use of gamma irradiation is recommended in cereals since it is a safe technology to ensure food security and safety and to overcome strict quarantine quality standard in international trade.

5. Further researches on the methods of reduction or removal of different types of mycotoxins is recommended.

6. Health authorities should make regular inspections to detect the amount of aflatoxin in food.

7. Strict laws should be applied to prohibit the use of aflatoxins contaminated materials in food industries.

SUMMARY

Occurrence of mycotoxins in cereal foodstuff is unavoidable. The attendant challenges to crop production, yield and quality loss is about 25% annually according to FAO.

Aflatoxin B_1 is the most potent hepatocarcinogen known in animals and it is classified by the International Agency of Research on Cancer (IARC) as Group I carcinogen meaning that it is a proven cancer-inducing agent. It also occurs in the environment contaminating a lot of different food and feed commodities. Aflatoxins are a group of mycotoxins produced in tropical and sub-tropical regions. Aflatoxins are hepatic and carcinogenic secondary metabolities of moulds that produce mainly from *Aspergillus flavus* and *Aspergillus paraciticus*. Aflatoxins contaminate a variety of agricultural commodities in countries with hot and humid climates.

The aim of this study was to assess the possible effect of gamma irradiation on the reduction of aflatoxin B_1 in some cereal grains and the impact on nutritive values including, ash, moisture, fat, protein, carbohydrates, crude fibers, calories, fatty acids profiles and amino acid profiles.

One group pre and post intervention study was performed on 60 samples (one kilogram for each sample) divided equally among the three cereals including maize, wheat, and rice.

To achieve this aim the following was carried out:

Samples (maize, wheat, and rice) were randomly selected from the local markets and wholesale markets in Alexandria city during June, July, and August-2013. Each one kilogram sample was subdivided into equal four sub-groups. Samples were stored in plastic bags at 4^{o} C until analysis.

A. The first quarter quantity of each cereal sub-sample (control sample) was taken to the central lab of High Institute of Public Health for the following analysis:-

1. Determination of aflatoxin B_1 by high performance liquid chromatography.
2. Proximate analysis for cereal samples include:
   - Determination of moisture contents
   - Determination of fat contents by Soxhlet method.
   - Determination of protein contents by Kjeldahl nitrogen method.
   - Determination of ash contents.
   - Calculation of carbohydrate contents.
   - Determination of crude fibers
   - Calculation of sample calories.
3. Preparation of methyl esters by sodium methoxide method followed by determination of fatty acid profile by gas liquid chromatography.
4. Determination of amino acid profile by amino acid analyzer.

B. The second quarter sub-sample of each cereal type was irradiated using gamma irradiation source from ^{60}CO at an absorbed dose level of 4 kGy each followed by analysis for aflatoxin B_1, proximate analysis, fatty acid profile and amino acid profile, analysis was performed as described previously.

C. The third quarter sub-sample of each cereal type was irradiated using gamma irradiation from ^{60}CO at an absorbed dose level of 6 kGy each followed by analysis for aflatoxin B_1, proximate analysis, fatty acid profile and amino acid profile as described previously.

D. The fourth quarter sub-sample of each cereal type was irradiated using gamma irradiation from ^{60}CO at an absorbed dose level of 8 kGy each followed by analysis for aflatoxin B_1, proximate analysis, fatty acid profile and amino acid profile as described previously.

The results of this study was statistically analyzed; data were fed to the computer and analyzed using IBM SPSS software package version 20.0 and significant data was taken at $p < 0.05$ using ANOVA test.

It was found that:

1. Maize samples contain the highest level of aflatoxin B_1 than wheat and rice.
2. Gamma irradiation is a suitable technique which reduces the levels of aflatoxin B_1 in cereal samples without affecting the nutritive values, at **4 KGy** the reduction percents of aflatoxin B_1 were 15.54%, 22.25%, and 27.46% for maize, wheat, and rice, respectively whereas at **6 KGy** the reduction percents of aflatoxin B_1 were 32.39%, 43.84%, and 56.38% for maize, wheat, and rice, respectively and the **8 KGy** radiation dose removed about 60.26% of the toxin in maize, 64.68% in rice and 69.29% in wheat samples.
3. Higher radiation doses than 8 KGy are required to remove the toxin until it reaches the legal limit (5ppb) according to FAO.
4. By increasing the radiation doses the percents of reduction of aflatoxin B_1 increase (dose dependent manner) in cereal samples.
5. The percents of reduction decrease with increasing the oil contents of cereals so maize had the lowest aflatoxin B_1 reduction level.
6. Gamma irradiation affect on fatty acid profiles of wheat and rice, causes reduction in mono-unsaturated fatty acid (oleic acid, C18:1) and poly-unsaturated fatty acid (linolenic acid, C18:3) which disappear completely in rice at 8 KGy, while in maize samples there was increase in the saturated fatty acid (palmitic acid, C16:0) and decrease in the mono-unsaturated fatty acid (oleic acid, C18:1) and this consistent with other studies.
7. Gamma irradiation affects slightly on amino acid profile of cereal grains in **maize** samples there is a reduction in phenyl alanine and threomine and increase in leucine, in **wheat** samples there is a decrease in tryptophan, isoleucine, phenylalanine, arginine and lysine and an increase in leucine and in **rice** samples there is increase in leucine and decrease in phenylalanine.

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الملخص العربى

يعتبر حدوث السموم الفطرية في المواد الغذائية (الحبوب) أمر لا مفر منه،.و من التحديات المصاحبة لإنتاج المحاصيل فقدان حوالي ٢٥% من المحاصيل سنويا بسبب السموم الفطرية على حسب ما اعلنته منظمة الاغذية والزراعة.

الافلاتوكسن ب١ من اخطر السموم الفطرية المعروفة في الحيوانات ومصنف على حسب الوكالة الدولية لأبحاث السرطان كمجموعة أولى مسرطنة وهذا يعني أنه من العوامل التى تحفز السرطان التي أثبتت جدواها، و الأفلاتوكسين ب١ هي مجموعة من السموم الفطرية المنتجة في المناطق الاستوائية وشبة الاستوائية، و الأفلاتوكسين ب١ ناتج من نواتج الايض الثانوية لفطر الاسبرجلس فلافس و الاسبرجلس براسيتكس ويلوث عدد كبير من المحاصيل فى البلدان ذات المناخ الحار والرطب.

إن الهدف من هذه الدراسة هو تقييم التأثير المحتمل لاشعة جاما على الحد من الافلاتوكسن ب١ وتأثير ذلك على القيم الغذائية بما في ذلك الرماد، والرطوبة، والدهون، والبروتين، والكربوهيدرات، والالياف الخام، والسعرات الحرارية، والأحماض الدهنية، والأمينية وقد اجريت الدراسة على عدد ستين عينة موزعة بالتساوي على ثلاث حبوب وهى الذرة والقمح والأرز ولتحقيق هذا الهدف تم تنفيذ ما يلي :-

لقد تم اختيار عينات عشوائية من الأسواق المحلية وأسواق الجملة في مدينة الإسكندرية فى شهر يونيه ويوليو واغسطس ٢٠١٣، و تم تقسيم كل عينة (واحد كيلوجرام) إلى اقسام متساوية لأربع مجموعات فرعية، تم تخزين العينات في أكياس بلاستيكية في درجة تبريد اربع درجات حتى يتم التحليل.

اولا- تم أخذ الربع الأول من كل عينات الحبوب الفرعية (العينة الضابطة) إلى المختبر المركزي للمعهد العالي للصحة العامة لاجراء التحاليل التالية:

١- تحديد نسبة الأفلاتوكسين ب١ بجهاز الكرماتوجرافيا السائل عالى الكفاءة.

٢- تحليل محتوى الحبوب من المكونات الغذائية ويشمل:

- تحديد محتوى الرطوبة
- تحديد محتوى الدهن.
- تقدير محتوى البروتين.
- تحديد محتوى الرماد.
- تحديد نسبة الالياف الخام
- حساب محتوى الكربوهيدرات.
- حساب السعرات الحرارية.

٣- تحضير استرات الميثيل للاحماض الدهنية بطريقة الصوديوم ميثوكسيد ثم تحليل الأحماض الدهنية بواسطة جهاز كروماتوجرافيا الغاز.

٤- تحليل الأحماض الأمينية بواسطة جهاز محلل الأحماض الأمينية.

ثانيا- تم تعريض الربع الثاني من العينة من كل نوع من الحبوب للاشعاع باستخدام مصدر أشعة جاما المنبعثة من الكوبلت-٦٠ عند جرعة ٤ كيلو جراى ثم اجريت لها نفس التحاليل السابقة.

ثالثا- تم تعريض الربع الثالث من العينة من كل نوع من الحبوب للاشعاع باستخدام مصدر أشعة جاما المنبعثة من الكوبلت-٦٠ عند جرعة ٦ كيلو جراى ثم اجريت لها نفس التحاليل السابقة.

رابعا- تم تعريض الربع الرابع من العينة من كل نوع من الحبوب للاشعاع باستخدام مصدر أشعة جاما المنبعثة من الكوبلت-٦٠ عند جرعة ٨ كيلو جراى ثم اجريت لها نفس التحاليل السابقة الذكر.

وقد تم تحليل نتائج هذه الدراسة إحصائيا و تبين ما يلي:

١- عينات الذرة تحتوي على أعلى مستوى من الأفلاتوكسين اكثرمن القمح والأرز.

٢- أشعة جاما تقلل من مستويات الأفلاتوكسين ب١ في عينات الحبوب دون التأثير على القيم الغذائية.

٣- اشعة جاما عند ٤ كيلو جراى، قللت من نسبة افلاتوكسين ب١ بمعدل ١٥.٥٤%، و ٢٢.٢٥ % و ٢٧.٤٦، فى الذرة والقمح والارز على التوالى، وعند ٦ كيلو جراى قللت من افلاتوكسين ب١ بمعدل٣٢.٣٩ %، و٤٣.٨٤، و٥٦.٣٨% فى الذرة والقمح والارز على التوالى.وجرعة الاشعاع ٨ كيلو جراى إزالت حوالي ٦٠.٢٦٪ من السم في الذرة، ٦٤.٦٨٪ في الأرز، ٦٩.٢٩% فى القمح.

٤- وبناءعلى هذه النتائج يفضل استخدام الجرعات الإشعاعية اعلى من ٨ كيلو جراى حتى يصل السم للمعدل المسموح به قانونا على حسب ما اعلنتة منظمة الاغذية والزراعة (فاو).

٥- لقد بينت الدراسة ان زيادة نسبة الزيوت فى الحبوب يكون عاملا من عوامل انخفاض نسبة الاقلال من افلاتكسن ب١، حيث ان اقل انخفاض بواسطة الاشعاع.كان فى حبوب الذرة نظرا لاحتوائه على محتوى اعلى من الزيوت وهذا ما تم تاكيده فى دراسات أخرى.

٦- تؤثر أشعة جاما على بعض الأحماض الدهنية فى القمح والارز، حيث تسبب انخفاضا فى الحمض الدهني الاحادي غير المشبع (حامض الأوليك) و الحمض الدهني العديد غير المشبع (حمض اللينولينيك) الذى أختفى نهائيا فى حبوب الارز عند جرعة الاشعاع ٨ كيلوا جراى ، اما فى الذرة فحدث زيادة فى الحمض الدهنى البلمتك ونقص فى الحمض الدهني الاحادي غير المشبع (حامض الأوليك)، وهذا ينطبق مع العديد من الدراسات.

٧- تؤثر أشعة جاما قليلا على الأحماض الأمينية فى الحبوب، فى حبوب الذرة حدث زيادة فى الليوسين اما الفينيل ألانين والثريومين فيقل كل منهما، اما حبوب القمح فحدث انخفاض فى كل من التربتوفان، والايزوليوسين، والفنيل ألانين، والارجنين، والليسين، وزيادة فى الليوسين اما حبوب الارز فحدث زيادة فى الليوسين وانخفاض فى الفينيل ألانين ويختلف مقدار الزيادة والنقصان بأختلاف نوع الحبوب وجرعة الاشعاع.

جامعة الإسكندرية
معهد البحوث الطبية
قسم الفيزياء الحيوية الطبية

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رسالة مقدمة

لقسم الفيزياء الحيوية الطبية ـ معهد البحوث الطبية ـ جامعة الإسكندرية
ضمن متطلبات درجة

الماجستير

فى

الفيزياء الحيوية الطبية

مـــن

عايدة صابر حمودة احمد

بكالوريوس العلوم (كيمياء حيوية خاصة) ، ١٩٩٦
كلية العلوم ، جامعة الإسكندرية

[أكتوبر/ ٢٠١٤]

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رسالة مقدمة من

عايدة صابر حمودة احمد

للحصول على درجة

الماجستير

فى

الفيزياء الحيوية الطبية

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