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Mycotoxin residues in different chicken products by HPLC and their inactivation using Gamma radiation

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ABSTRACT

Mycotoxin residues were studied in different chicken products by HPLC and their inactivation using Gamma radiation. 120 different chicken products were examined for the presence of mycotoxins (AFB1, AFB2, AFG1, AFG2, and OTA) using highly accurate and precise HPLC-FLD assay. High recovery was achieved by purification of the sample extract using immunoaffinity columns (IAC). Derivatization of AFs was carried out with a 0.005% aqueous solution of pyridine hydrobromide perbromide (PBPB) by utilizing a post-column LC pump. The incidence of mycotoxins in analyzed chicken products showed that the level of Afla B1, Afla B2, and Afla G2 were 10 % for each and of Afla G1 and Ochra A were ranged from 10 to 16.7% for each. The results showed that the highest concentration of examined mycotoxins was present in the liver as the liver is the harbor site of mycotoxin residues. The influence of different gamma irradiation rays (6, 8, and 10 kGy) was studied on the reduction of the existed in examined chicken products. There is a positive connection between the elevation of gamma irradiation dose used to the samples and the reduction level of total mycotoxins current in these samples, whereby, the most reduction percentage of mycotoxins were achieved at 10 kGy; it reaches 19.6% for total mycotoxins, 27% for AF B1, 40.43% for AF B2, 59.42% for AF G1, 92.15% for AF G2, and 73.44% for OTA.

Key words: *Mycotoxin- Chicken products- HPLC- Gamma radiation.*

INTRODUCTION

Mycotoxins are natural secondary toxic metabolite products of fungal origin, which contaminate our foodstuff [1]. Aflatoxins (AFs) are very important in mycotoxins and include aflatoxin B1, B2, G1, and G2. Aflatoxins are outputted by different pathways with many strains of *Aspergillus spp.* as secondary metabolites [2, 3].

Less hygienic and qualified handling of carcasses on preparation after slaughtering and also improper evisceration, result in high bacterial contamination. Moreover, bad cooling leads to spread of mold contamination, so food corruption occurs, which increases the amount of toxines like aflatoxins [4, 5].

Aflatoxins have been extensively achieved estimate techniques of work, comprehensive carcinogenic activity in humans. Contemporary research observed that the powerful, considerable, and positive connections between the concentration of aflatoxin intake and liver cancer (**Report on Carcinogens, 12th Ed., 2011**). The International Agency for Research on Cancer (IARC) made enough proof in humans for the carcinogenicity of natural aflatoxins [6]. These results were confirmed in two following reestimates [7, 8] and reported that aflatoxin B1 may be as a human carcinogen.

Ochratoxin A is a secondary toxic metabolite, mainly produced by *Penicillium verrucosum* and *Aspergillus ochraceus* [9]. These fungi can proliferate in various climates. *Penicillia* usually is in temperate regions and can grow in low temperatures even at 5°C, while *Aspergilli* grow in tropical regions [10]. When formed, OTA survives from most food processing stages such as cooking, fermenting, and roasting [11, 12]. There are many reports on the immunosuppressive, fertility inhibition, and carcinogenic influences of this toxin. The major effect of OTA is nephropathy in humans [13].

Accumulation of aflatoxin residues in human in acute cases is lethal due to intoxication, in chronic cases leads to hepatocellular carcinoma [14, 15]. The International Agency for Research on Cancer classified Aflatoxins in group 1, i.e. carcinogen for human and according to some research aflatoxin B1 is the highly toxic [7, 16].

As a consequence of the greatest toxicity of mycotoxin, more processes have been utilized to decrease and remove them from various nutrition. The better process to decrease the mycotoxin in nutrition is preventing the growth of mycotoxin in the field, but this usually is not enough, therefore more processes are necessary.

The studies, accomplished worldwide have proven that ionizing irradiation transformation may be an influential substitution to decrease the contamination of seeds and nutrition or to treat previously output of mycotoxins [17]. Therapy with ionizing irradiation is believed as an influential physical method for food protection [18].

Inconsistent information exists about the performance of γ radiation on the removal/demolition of mycotoxins from food matrices. Some studies showed considerable decreases and in more issues, the full removal of mycotoxins in different foods; [19-22]; other information is in full discrepancy with these studies [23, 24].

This research was aimed to study the incidence of mycotoxins (AFB1, AFB2, AFG1, AFG2, and OTA) in different chicken products and investigate the effect of γ irradiation on samples with mycotoxins.

Therefore, according to the statutory provisions regulating mycotoxin levels in food, a great number of examinations are performed for formal monitoring the objectives to include food safety. Concerning the wide range of matrices influenced by contamination, the ability to be an appearance and a very wide range of mycotoxin concentrations and multi-matrix methods are strongly needed. RP-HPLC method can be used to identify ochratoxin A and aflatoxins in various chicken products.

EXPERIMENTAL

Samples

30 samples from each 120 different chicken products (chicken wings, chicken nuggets, chicken liver, and chicken thigh) were prepared. The samples were collected from different supermarkets of Al Sharqia. Each sample was represented by 20 grams. The samples were placed in plastic bags then transferred to the laboratory in an ice box with no undue delay.

Instrumentation and Analytical Conditions :

The HPLC system has an autosampler injector, a quaternary pump, model 1200, and UV-Vis detector (Agilent) with a Jasco FP1520 fluorescence detector (Jasco Corporation, Tokyo, Japan). The excitation wavelengths were 365 nm for AFs and 333 nm for OTA, the emission wavelengths were 442 and 463 for AFs and OTA, respectively and the quantitative analysis was performed and calculated from the area under curves automatically extrapolated by the software.

Aflatoxins (B1, B2, G1, and G2) and ochratoxin A were separated on a pre-packed 250 mm, 4.6 mm i.d., 5 µm particle size, LiChrospher C18 column from Agilent.

Two solvents were used: solvent A (40% methanol, 2% acetic acid in water) and solvent B (80% methanol, 2% acetic acid in water) at a flow rate of 1 ml/min. The gradient was applied as mentioned in table (1).

Table 1: Time table of gradient mobile phase

Time/ min.	Solvent A %	Solvent B %
0	100	0
14	100	0
16	35	65
30	35	65
31	100	0
40	100	0

Derivatization of AFs was performed with a 0.005% aqueous solution of Pyridine Hydrobromide Perbromide (PBPB) by using a post-column LC pump (zero-dead volume Tpiece, reaction tubing minimum 450 × 0.5 mm id in PTFE) (LC pump Lab flow 2000, Lab service Analytica, Bologna, Italy) at a flow rate of 0.4 ml/min.

Before using the mobile phase was filtered through a 0.45 µm nylon membrane filter and degassed with ultrasonic bath for 15 min.

Reagents and Solvents:

Methanol was HPLC grade (Honeywell Co, Germany,).

Deionized water (DW) was obtained from a Milli-Q-system (Millipore, Molsheim, France).

Potassium chloride, anhydrous disodium hydrogen phosphate, potassium dihydrogen phosphate, and sodium chloride analytical grade were obtained from J.T. Baker (Deventer, The Netherland).

Phosphate buffer solution (PBS) was made by using 8 g sodium chloride, 0.2 g potassium chloride, 0.2 g potassium dihydrogen phosphate, and 1.2 g anhydrous disodium hydrogen phosphate, which were added to distilled water (900 ml). After dissolving, the pH was adjusted to 7.4 (with 0.1 M HCl or 0.1 M NaOH as appropriate), and the solution was made up to 1 L.

Immunoaffinity columns (IAC) AFLAOCHRAPREP®, OCHRAPREP®, and AFLAPREP®, (R-Biopharm Rhône Ltd., Glasgow, UK) were used for the clean-up step.

Reference Standard:

Aflatoxins and OTA certified reference acetonitrilic solutions (3µg/ml) were supplied by Sigma-Aldrich Co.

Extraction and clean-up:

5gm of … was weighted into a polypropylene tube. 0.5 g of sodium chloride and 25 ml of methanol (80%) was added and mixed at high speed for 3 min. The extract was filtered through a filter paper and 3 ml of it was pipetted and diluted with 3 ml of PBS, thoroughly mixed, and centrifuged for 10 min at 10,000 rpm. 4 ml of the diluted sample was applied to the conditioned immunoaffinity column (IAC) and washed with 1 ml of PBS. The mycotoxins were eluted in a 2-step procedure. First, 1.0 ml of methanol was applied to the IAC and let it flow through under gravity. Then the eluate was collected in calibrated 5 ml volumetric flask. After waiting for 1 min, the second portion of 1.0 ml methanol was applied and the air was passed through the column to collect the remaining few drops. Finally, a 5 ml volumetric flask was filled and marked with DW, mixed well, and stored at +4 ◦C prior to analysis.

Validation of analytical method:

ICH, 2005 and **USP, 2017** guidelines were used to validate the method.

Limit of Detection (LOD) and Quantification (LOQ) were calculated based on the standard deviation (S) of intercept and slope (b) LOD = 3.3×S/band, LOQ = 10×S/b

System Suitability Test: Relative standard deviations of the number of theoretical plates, tailing factor, peak area, capacity factor, and retention time were measured to test the suitability of the system.

Accuracy and recovery: The standard additions at different concentrations were prepared by adding known quantities of AFs & OCA. The samples were analyzed against standard solutions with the same concentrations. The accuracy was then calculated from the test results as a recovery percentage.

Precision: It was determined using 5 replicates of each standard solutions and evaluating the relative standard deviation of repeatability (RSD %).

Selectivity and specificity: The verification of the selectivity was conducted by evaluating the standard addition on a blank matrix.

Acceptance criteria: There was not any interference between the peaks of extracted solvents or any impurities and the pure standard.

Irradiation effects on mycotoxins reduction:

Chicken product samples with high positive results were packed into polyethylene pouches and irradiated in three replications, with the doses of 6, 8, and 10 KGy by using ^{60}Co γ rays (Gamma Cell mold 220 apparatus, NCRRT, Nasr City, Cairo, Egypt) [25].

Statistical Analysis:

The obtained results were statistically evaluated by using IBM SPSS Statistics 20 to analyze the statistical significance of the experimental data. The results of the concentrations of aflatoxin in the analyzed samples were subjected to ANOVA using Fisher's LSD.

RESULTS AND DISCUSSION

Intra-lab validation:

The results of mycotoxins assay validation were illustrated in table (2), showing that the used method with high accuracy and extremely precise method as the Intra-day precision (RSD %) did not exceed 1.81% (< 2%,

recommended by **USP, 2017**) and the inter-day precision did not exceed 2.63% (< 6%, recommended by Aziz et. al., 2004) [26].

There was high resolution of chromatograms, shown in the results as the retention time of Afla G2, G1, B2, B1, and OTA standards at 0.803, 1.002, 1.901, 2.713, and 7.803 min.

Selectivity and specificity: As shown in fig (1 & 2), HPLC chromatograms of mycotoxins' pure standards and spiked matrix at different levels, showed no matrix interferences and no interfering peaks were obtained with the same retention times (RT) of mycotoxins' peaks.

Mycotoxin residues in different chicken products:

Due to the toxicity and carcinogenicity impact of mycotoxin residues on human public health, our study included detecting the residues on mycotoxins (Aflatoxins types; B1, B2, G1, G2) and Ochratoxin A (OTA) in different chicken product samples.

The data, represented in table (3) show the incidence of mycotoxins in different chicken product samples in which, the level of Afla B1, Afla B2, and Afla G2 are 10 % for each sample and Afla G1 and Ochra A are from 10 to 16.7% for each sample.

Table 2: validation sheet of mycotoxins

Parameter	Afla B1	Afla B2	Afla G1	Afla G2	Ochra A
Retention time (min.)	2.713	1.901	1.002	0.803	7.803
Linearity range (ppb)	0.015-0.3	0.015-0.3	0.015-0.3	0.015-0.3	0.015-0.3
Regression equation	y=11826x-26.56	y = 8822.8x-38.892	y = 2406.3x-10.79	y = 7790.8x-60.235	y = 8845.1x - 9.9861
Correlation coefficient (R^2)	0.9985	0.9961	0.9954	0.9995	0.9999
Slope (a)	11826	8822.8	2406.3	7710.7	8845.1
Intercept (b)	26.555	38.892	10.788	60.235	9.9861
LOD	0.002	0.014	0.015	0.014	0.008
LOQ	0.005	0.041	0.045	0.043	0.022
Accuracy	99.9 ± 0.611	99.8 ± 0.6	98.8 ± 0.47	96.4 ± 0.17	100.1 ± 0.11
Recovery %	98.7	92.2	95.9	101.82	100.07
Intra-day precision (RSD%)	0.07	0.45	0.23	1.81	0.046
Inter-day precision (RSD%)	0.34	1.63	0.73	2.63	0.23

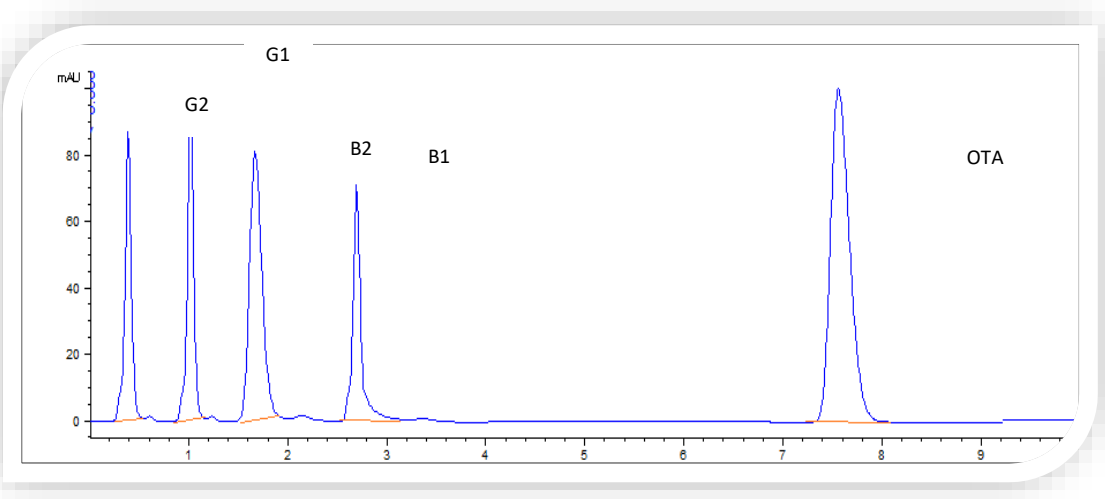

Figure 1: chromatogram of Afla G2, G1, B2, B1, and OTA standards at the concentrations of 0.03, 0.075, 0.02, 0.015, and 0.02 ppb, respectively.

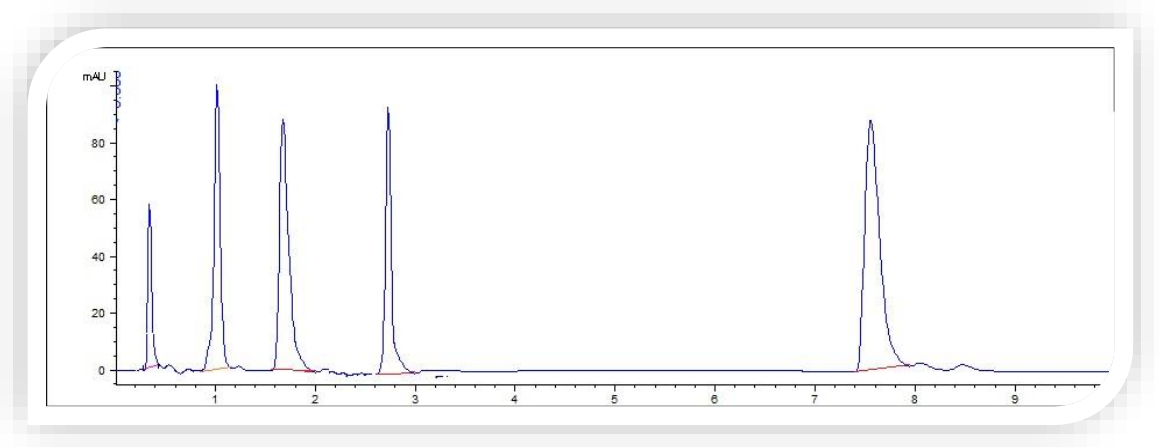

Figure 2: chromatogram of Afla G2, G1, B2, B1, and OTA spiked matrix at the concentrations of 0.015, 0.06, 0.03, 0.03, and 0.02 ppb, respectively

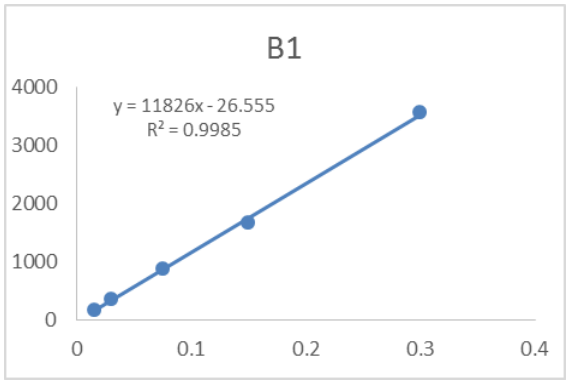

Figure 3: Standard curve of Afla B1

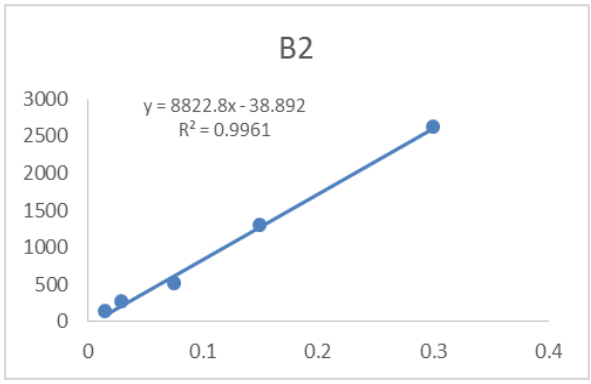

Figure 4: Standard curve of Afla B2

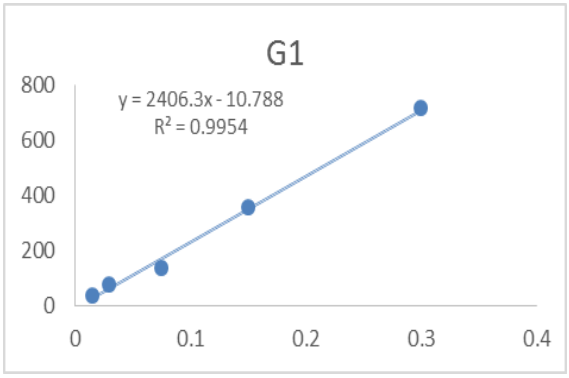

Figure 5: Standard curve of Afla G1

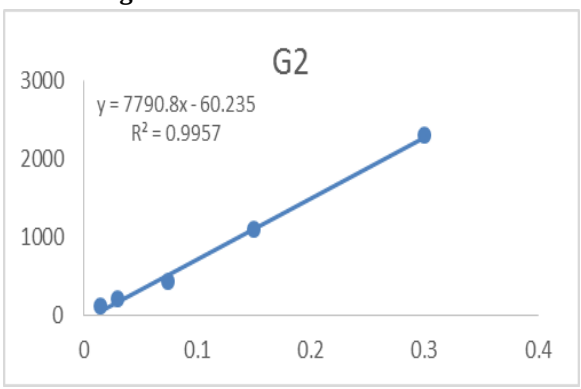

Figure 6: Standard curve of Afla G2

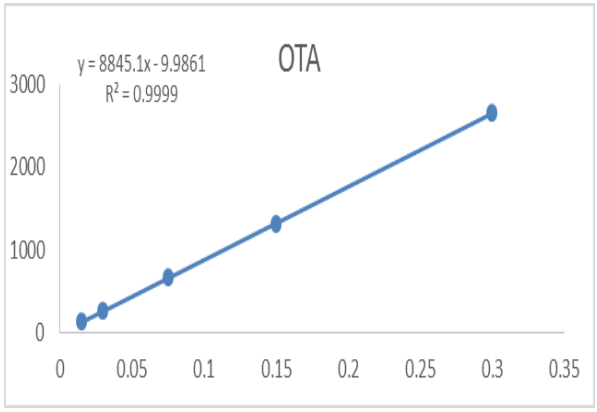

Figure 7: Standard curve of OTA

Table 3: Incidence of mycotoxin residues in chicken products samples

Mycotoxin	Type of sample	Samples no.	Positive samples	Percentage (%)
Afla B1	Chicken wings	30	-	0
	Chicken nuggets	30	3	10
	Chicken liver	30	3	10
	Chicken thigh	30	3	10
Afla B2	Chicken wings	30	-	0
	Chicken nuggets	30	3	10
	Chicken liver	30	3	10
	Chicken thigh	30	3	10
Afla G1	Chicken wings	30	-	0
	Chicken nuggets	30	5	16.7
	Chicken liver	30	3	10
	Chicken thigh	30	3	10
Afla G2	Chicken wings	30	-	0
	Chicken nuggets	30	4	10
	Chicken liver	30	3	10
	Chicken thigh	30	-	0
Ochra A	Chicken wings	30	-	0
	Chicken nuggets	30	3	10
	Chicken liver	30	5	16.7
	Chicken thigh	30	3	10

The data represented in table (4 & 5) show that the highest mycotoxin residues were found in chicken liver (4.89±1.83; 66%), followed by chicken nuggets (1.38±0.55; 18%), chicken thigh (1.17±0.65; 16%), and finally chicken wings (not detected).

The highest Ochra A residue was found in chicken liver (0.92±0.21), followed by chicken nuggets (0.86±0.28) and thigh samples (0.3±0.17). The data confirmed some of those of the previous studies obtained by ICH [27] in Serbia who recorded that the incidence of OTA in chicken gizzard, kidney, and liver samples of chicken was 26.6%, 28.3%, and 38.33%, respectively, with levels from 0.25 to 9.94 ng/g in gizzard, 0.1 to 7.02 ng/g in kidneys, and 0.14 to 3.9 ng/g in liver. In the Czech Republic, ochratoxin residues were reported 0.12 ppb in chicken meat.

Our data agree with those reported by Milićević et. al., 2011 who reported ochratoxin residues in the chicken burger (1.63 ppb), followed by chicken nuggets (1.04 ppb), luncheon (0.98 ppb), frankfurter (0.82 ppb), chicken thigh (0.68 ppb), pannet (0.43ppb), and finally chicken wings (0.29 ppb) [28]. While the incidence was much lower than that reported in Egypt by Hassanin et. al., 2016 in which the incidence of ochratoxin in chicken burger and luncheon was 70% and 80%, respectively. The residue of ochratoxin was very low in their study, i.e. 0.277 and 0.243 ppb in chicken burger and luncheon, respectively [29]. This could be explained by the fact that in our work we used HPLC-FLD, which considered a highly precise and accurate technique for the determination of mycotoxin residues.

The current results in tables 4 & 5 were consistent with the results of the studies conducted by Nahed et. al., 2016 and Resanović et. al., 2000, who declared that however aflatoxin residues found in meat, adipose tissue, stomach, muscles, liver, and kidneys but the harbor site of aflatoxin residues is liver [30, 31]. The results were also consistent the results of some researchers' studies, who showed that the highest concentration of AFB1 and the total aflatoxins were higher in liver than in kidneys and gizzard, respectively, while the lowest concentrations were in thigh and breast [14, 15, 20, 28, 32]. The present results completely disagree with those achieved by Darwish et. al., 2016 who detected that the residual concentrations were higher in the breast than in the liver [33].

Mycotoxin residues in different chicken products after exposure to gamma irradiation:

In all the analyzed samples, there was a positive relationship between the elevation of γ irradiation dose used to the samples and the reduction level of total mycotoxins, whereby, the most reduction percentage of mycotoxins were achieved at 10 kGy; it reached 19.6% for total mycotoxins, 27% for Afla B1, 40.43% for Afla B2, 59.42% for Afla G1, 92.15% for Afla G2, and 73.44% for OTA. These results agree with Abo El-Yazeed et. al., 2015 who found that in the dose of 10 kGy the degradation of AFB1 reached the highest values at 87.8%, 81.1, 84.6, 68.8, and 58.6 for rice samples, corn, peanuts, unpeeled pistachios, and peeled pistachios, respectively. Their studies indicated the possibility of using γ irradiation as a means of AFB1 degradation in foods to levels lower than the maximum allowed levels [34]. While Giuseppe et al. showed that the gamma irradiation dosages, ranged from 0 to 15 kGy influence the lowering of mycotoxins concentration in almond samples. The maximum reduction was found at 15 kGy and it was 23.9%, 21.11%, 16.62%, 19.25%, and 10.99%, for OTA, AFG1, AFG2, AFB1, and AFB2, respectively. The results indicated that γ radiations were not effective in completely destroying ochratoxin A and aflatoxins, even at 15 kGy.

Some studies observed considerable decreases and in more issues the full removal of mycotoxins in different foods. Jalili, et al., 2010 found that the Gamma-ray can decrease mycotoxins, i.e. aflatoxins B1, B2, G1, and G2 as well as ochratoxin A (OTA) in black pepper. The most decreases have appeared at 60 kGy, which was 52%, 43%, 24%, 40%, and 36%, respectively. It could be noticed from the results that the gamma rays even at 60 kGy were not influential in fully break down of ochratoxin and aflatoxins. These findings were confirmed by the results obtained by Herzallah et. al., 2008 who reported that even at 30 kGy in peanuts, the percentage of decreases reached around 61% and the average demolition was nearly constant after the dose of 15 kGy [21]. Moreover, the findings were in approval with Ghanem et. al., 2008 who showed the 83% lowering of aflatoxin after a 20-kGy dose of γ-irradiation on peanuts and yellow corn [35]. On the inversion, Farag et. al., 1995 showed that the dose of 20 kGy was enough to fully destroy AFB1 in peanuts, yellow corn, and cottonseed meal [36].

Herzallah *et al.*, 2008 reported that the average degradation increases by increasing the irradiation dose so that after an irradiation dose of 25 kGy the percentages of the aflatoxins were lowered 40.1 and 42.7% in T3 and B1 aflatoxins, respectively.

Jalili *et al*., 2012 investigated the γ radiation (^{60}Co) efficacy for decontamination of aflatoxins G1 (AFG1), G2 (AFG2), B1 (AFB1), B2 (AFB2), and ochratoxin A residues in the experimentally contaminated white and black pepper samples. The levels of Mycotoxin were determined by HPLC after immune-affinity column (IAC) chromatography. Both the gamma irradiation dose and moisture content showed considerable influences (P<0.05) on mycotoxin lowering. The most toxin lowering was found at 18% moisture content and 30 kGy, which were 55.2%, 50.6%, 39.2%, 47.7% and 42.9% for OTA, AFB1, AFB2, AFG1, and AFG2, respectively.

Our results are in full disadvantage with the findings obtained by Jalili et. al., 2012 Hooshmand et. al., 1995 who found that different radiation doses of 5, 7.5, 10 or 20 kGy, on spiked grain samples, did not significantly affect aflatoxin B1 [23, 24].

Table 4: Results of mycotoxin residues in positive chicken products samples

Type of sample	Type of sample	No. of positive samples	Mean ± SE (µg/kg)	Range (µg/kg)	
				Min.	Max.
Afla B1	Chicken wings	ND	ND	ND	ND
	Chicken nuggets	3	5.7±1.84	2.96	9.2
	Chicken liver	3	17.27±5.58	8.97	27.87
	Chicken thigh	3	4.73±1.53	2.46	7.63
Afla B2	Chicken wings	ND	ND	ND	ND
	Chicken nuggets	3	0.85±0.51	0.28	1.87
	Chicken liver	3	4.42±3.71	0.4	11.8
	Chicken thigh	3	0.7±0.43	0.2	1.55
Afla G1	Chicken wings	ND	ND	ND	ND
	Chicken nuggets	5	0.48±0.2	0.16	1.27

	Chicken liver	3	3.91±2.56	1.21	9.02
	Chicken thigh	3	0.21±0.07	0.08	0.33
Afla G2	Chicken wings	ND	ND	ND	ND
	Chicken nuggets	4	0.05±0.03	0.013	0.13
	Chicken liver	3	0.58±0.22	0.23	0.98
	Chicken thigh	ND	ND	ND	ND
Ochra A	Chicken wings	ND	ND	ND	ND
	Chicken nuggets	3	0.86±0.28	0.28	0.84
	Chicken liver	5	0.92±0.21	0.35	1.6
	Chicken thigh	3	0.3±0.17	0.47	1.41

Table 5: Distribution of mycotoxins in different chicken products

Mycotoxins	Liver	Nuggets	Thigh
Mean	4.892176	1.379766667[a]	1.165544875
SD	7.529848	2.325311583	2.26613666
SE	1.826256	0.548081196	0.654177305

a: Significant ($p < 0.05$) with respect to liver results using ANOVA test

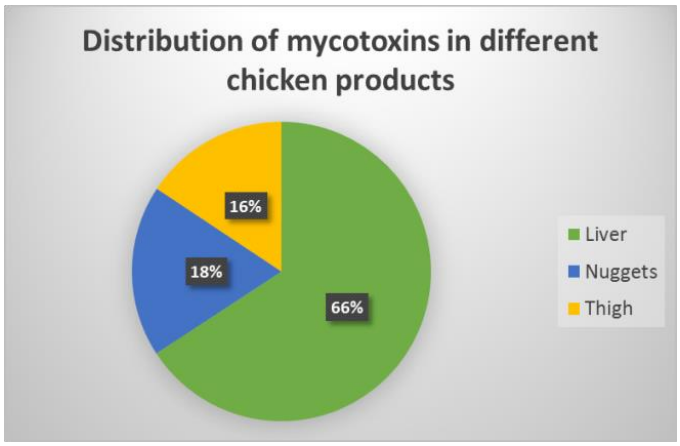

Figure 8: Chart showing mycotoxin exist in different chicken products

Table 6: Results of mycotoxins in different chicken products after exposure to gamma irradiation

Type of sample	**Type of sample**	**conc. ppb (Control)**	**Irradiation dose (kGy)ppb (Reduction %)**		
			6	**8**	**10**
Afla B1	Chicken nuggets	9.2	8.9 (3.6%)	7.4 (19.7%)	6.12 (33.7%)
	Chicken liver	27.87	26.2 (6%)	23.1 (17.5%)	20.9 (25%)
	Chicken thigh	7.63	7.08 (7.5%)	6.34 (16.5%)	5.6 (26.6%)
Afla B2	Chicken nuggets	1.87	1.74 (6.8%)	1.3 (20%)	1.13 (39.6%)
	Chicken liver	11.8	11.5 (6%)	9.12 (22%)	7.14 (39.5%)
	Chicken thigh	1.55	1.4 (10%)	1.2 (22%)	0. 8 (48.4%)
Afla G1	Chicken nuggets	1.27	1.08 (15%)	0.76 (40%)	0.57 (55%)
	Chicken liver	9.02	7.7 (15%)	6.3 (30%)	3.6 (60%)
	Chicken thigh	0.33	0.28 (15.2%)	0.14 (42.2%)	0.03 (90%)
Afla G2	Chicken nuggets	0.13	0.11(15.4%)	0.07(46.2%)	0.018(86%)
	Chicken liver	0.98	0.86 (12%)	0.54 (45%)	0.084(91.4%)
Ochra A	Chicken nuggets	0.84	0.63 (25%)	0.5 (40%)	0.03 (96.4%)

	Chicken liver	1.6	1.2 (25%)	0.88 (45%)	0.64 (60%)
	Chicken thigh	1.41	1.13 (20%)	0.85 (60%)	0.35 (75%)

Table 7: Total mycotoxins after gamma irradiation exposure

Mycotoxin type	**(Control) conc. ppb ± SE**	**Irradiation dose (kGy)**		
		6	**8**	**10**
AF B1	14.9±6.5	14.06 ± 6.1 (5.6%)	12.28 ± 5.42 (17.6%)	10.87 ± 5.02 (27%)
AF B2	5.07±3.36	4.88 ±3.31 (3.75%)	3.87±2.62 (23.67%)	3.02±2.06 (40.43%)
AF G1	5.15±2.75	4.39±3.31 (14.76%)	3.53±2.77 (31.46%)	2.09±1.52 (59.42%)
AF G2	0.56±0.43	0.49 ± 0.38 (25.4%)	0.31± 0.235 (53.08%)	0.051±0.033 (92.15%)
OTA	1.28±0.23	0.99 ± 0.18 (22.66%)	0.74±0.12 (42.19%)	0.34±0.18[ab] (73.44%)
Total mycotoxins	5.39 ± 2.03	4.99 ± 1.92 (7.54%)	4.18 ± 1.68 (16.2%)	3.358 ± 1.51 (19.6%)

a: Significant ($p < 0.05$) with respect to control results using ANOVA test Table

b: Significant ($p < 0.05$) with respect to dose Radiation Dose (6 kGy) results using ANOVA test

CONCLUSION

This study investigated the incidence of mycotoxins (OTA, AFG1, AFG2, AFB1, and AFB2) in different chicken products and found that the highest concentration of examined mycotoxins was present in the liver: as it is the harbor site of mycotoxins residues.

The used HPLC-FLD assay method considers a beneficial analytical tool to implement various kinds of mycotoxin and/or multi-matrix analyses, depending on either the laboratory studies or official control purposes.

The influence of different gamma irradiation rays (6, 8, and 10 kGy) was studied on the lowering of the mycotoxins (OTA, AFG1, AFG2, AFB1, and AFB2) in different chicken samples. There was a positive relationship between the elevation of gamma irradiation dose used to the samples and the reduction level of total mycotoxins current in these samples, whereby, the most reduction percentage of mycotoxins were achieved at 10 kGy; it reached 19.6% for total mycotoxins, 27% for Afla B1, 40.43% for Afla B2, 59.42% for Afla G1, 92.15% for Afla G2, and 73.44% for OTA.

It is not potential to enhance the dose of ionizing radiations since the FAO/IAEA/WHO Expert Committee on Food Irradiation concluded already in its report of 1981 that "the irradiation of any food commodity up to an overall average dose of 10 kGy presents no toxicological hazard, hence, toxicological testing of food so treated no longer required."

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