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Investigation of aflatoxin M1 reduction in milk by solution of radioactive iodine131

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ABSTRACT

Aflatoxins are toxins which are usually produced by a kind of Aspergillus fungus named Flavus, Parasiticus, and Numius. There are 18 kinds of Aflatoxins have been discovered by scientists and Aflatoxin B1 is the most toxic and carcinogenic. Taking aflatoxins present in food causes lots of diseases like liver diseases, alcoholic liver, mutagenesis, and malformation in animals. It also has some other outcomes like weakness of immune system, decrease in growth, decrease in eating, decrease in lactation in cows and abortions. To reduce the aflatoxin in milk, there are different methods and in this paper have done that by iodine solution. Milk is the most perfect food that can be used by humans. This food consists of a complicated compound including fat, proteins, sugar, lactose, minerals, vitamins, and water. A significant amount of milk is water and it may be due to the iodine present in the water. Iodine is a radioactive element which existence in milk during production and storing causes some physical and chemical changes in milk and its components. This paper is carried out in two stages. In the first stage, the dose amount of absorbed Gama was measured during one day with a milk with aflatoxin impregnated with 1Bq/m^3 iodine based on Nano rad with MCNPX software. In the second stage the Reduction of aflatoxin M1 with adding radioactive iodine to milk was investigated.

Key words: Milk, Aflatoxin M1, Reduction, Iodine131, Absorbed Dose

INTRODUCTION

Milk is a mixture of protein, fat, lactose, minerals, etc(Jensen ,1995). The most ingredient is water with 87 % and the approximate amount in 100 grams (protein, lactose, minerals, vitamins, and aflatoxin is mentioned (Lindell ,1968;Luinge et al,2005;Enb et al, 2009;lindmarkm, 2008). If aflatoxin exists in milk, development processes such as pasteurization and sterilization cannot reduce the amount of it in milk(

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Sadeghi et al, 2010) .The results show that sterilized and pasteurized milks also had high contamination with aflatoxin which proves the high resistance to heating processes (Darayi et al,2010).A study which was carried out in Babul city on collected milk from 144 supermarkets in the winter of 1384 and summer of 1385 shows that the amount of aflatoxin M1 contamination in milk was 100 %. The average amount in 1385 summer was 85 Nano-gram per liter (ng/l) and 91% of the samples had more than 200 ng/l contaminations, whereas in the winter, it was equal to 101 ng/l (Darayi et al,2010).Another experiment took place in Kermanshah city where 6 samples per week and totally 320 samples per year were accidentally taken in four seasons from four milk pasteurization factories in Kermanshah. The amount of aflatoxin in 295 samples were above Codex standard (500 ng/l) and European standard (50 ng/l). The total average was 1200 ng/ l (Gholampoor et al , 2008).The study carried out in Kordestan city show that less than one-twentieth of the samples had aflatoxin M1 contaminations above Codex standard (Hazir et al, 2009).Another study which was carried out in Gonabad showed that a high percentage of the milk samples had above standard aflatoxin amount. In average, 58 % of the samples had above standard aflatoxin amount (Mokhtarian et al, 2005).The amount of contamination with aflatoxin M1 in Kerman factories compared with Tehran and Yazd factories had been shown (1ppb=1µg/l). Aflatoxin amount in Jiroft (a town in Kerman) Pegah pasteurized milk factory has been 20 ng/l which is less than Codex and European standard, and in Kerman pasteurized Pegah factory, it has been 65 ng/l which is less than less than Codex and above European standard. It has been 60, and 75 ng/l in Choopan pasteurized factory in Tehran and Isatis in Yazd respectively which are less than Codex and above Codex standard (Noor Mohammadi et al,2012). The results of a study which was done to determine the amount of aflatoxin M1 in industrial dry milk distributed in Tehran city show than 100% of them were contaminated with aflatoxin M1(Kamkar, 2011).The aflatoxin amounts in spring, autumn, and winter were 51 to 914, 32 to 640, and 32 to 879 ng/kg respectively. Approximately, 81 % of the samples show a contamination higher than European standard (50ng/kg), and 72% of the samples higher than Iran and Codex standard (500ng/kg)(Kamkar, 2011). Another research was carried out to survey the amount of aflatoxin M1 contamination in raw and pasteurized milk in Isfahan and Yazd. The contamination was 94% higher in Yazd province compared to Isfahan. 84/6% and 43% of the milk in Yazd and Isfahan have above standard contamination respectively. In another research, 428 samples of raw, pasteurized milk, and the feed were experimented in Shiraz in all seasons. It concludes that 43% of the feed had above standard aflatoxin M1 more than standard about 20mg/l, and 14% of the pasteurized milk and 38% of the raw milk had above Codex contamination. This study showed that there is a relation between feed contamination and milk. There is also a higher contamination in autumn and summer than spring and winter which seems to be due to high humidity in autumn and high temperatures in summer (Ersali et al,2009).The 75 samples of Mazandaran province factories' milk were experimented. The contamination in 37% of the samples was according to the European standard and the contamination of 62% of them was above Codex standard (Gholi pour et al,2012) .The 50 samples of milk were chosen from the two dairy providers companies of Tehran medical sciences university. 84% of them were contaminated with M1 aflatoxin but only 4% of them were above Iran standard (50 ng/l). Although only a small percentage of the milk was contaminated, there is a huge concern for the existence of aflatoxin M1 which means that dairy cows are exposed to B1 aflatoxin (Riazipour etal, 2010). Iodine can be effective by Gama and beta rays emission on milk mixture before drinking or damage human body parts after drinking. To check these changes, we need to check the received dose from Gama, Beta, and Alpha rays from iodine. First, chemical formula of milk mixtures and their percentages and also the exact percentages of milk elements that have been extracted from different sources.(Mansourbahmani et al, 2013**)** and have been put into the input file MCNPX code. The present iodine in milk is considered as a source uniformly distributed over the volume. Range of gamma and beta radiation from iodine along with the percentages of each is extracted and used.By running the written input file, the received dose of the present iodine in milk in aflatoxin was calculated. After dose calculation,The Reduction of aflatoxin M1 with adding radioactive iodine to milk was investigated.

MATERIALS AND METHODS

Initially, six containers containing 17 cm^3 milk with the amounts of 1, 2, 6, 4 mCi iodine 131 and two containers containing milk without iodine were chosen. Then, the four iodine-containing containers and one of the two not iodine-containing containers were separated and were kept away .After 15 days, the aflatoxin M1 amount in all six containers were measured.

DESCRIPTION OF THE INPUT CARD OF MONT CARLO CODE

For investigation of iodine effect on aflatoxin M1 in milk a Mont Carlo code was written and run in two ways. Firstly, an input file is introduced to measure the received dose on aflatoxin M1 by present iodine in milk. The source of iodine in milk volume was considered with steady distribution. The iodine Gamma and Beta energy data have been entered in the source card. For Monte Carlo simulation of gamma and beta dose in milk' aflatoxin the milk percent elements must be extracted. Milk is a mixture of water, lactose, protein and etc that the percent elements in milk have been extracted by Mansouri et al,2013 and are shown in table 1.

CALCULATION OF THE MILK's AFLATOXIN RECEIVED DOSE

To measure the absorption dose, the f6 and f8 tally in MCNPX code are used. In f6 tally, just the primary electrons from the interaction of Beta and Gama with the current elements in each part are measured. The unit is Jerk/g. But in f8 tally, the energetic secondary electrons are also considered and the remained effects in each cell are shown by MeV.As the measured dose is normalized by the code for a photon, to measure the dose from the iodine decay in the environment, we need to multiply the result by the number of Gama rays from iodine decay. Iodine density in milk is based on Bq/m^3 which shows the number of iodine decays per second in m^3. Finally, to change MeV into joule the results are multiplied by $1.6*10^{13}$. The written MCNPX code presents the mass of each cell according to the density of each compound.Therefore, the dose can obtain by Gray. As each gray is 100 rad and the conversion factor for measuring the equivalent dose by Sievert for proton in ISRU is 1, the dose can propose by Sievert. In this research, MCNPX code is used for radiation transport simulation. After running the MCNPX code for f6 tally with Sievert and rad units, the absorbed dose of Gama radiation in different mixtures of milk for iodine decay in milk has been extracted and the results have been shown in table3. According of table 1 results ,the beta absorbed Dose in milk's aflatoxin due of iodine 131 is great than gamma absorbed Dose . Therefore, because the high level of beta absorbed Dose, the aflatoxin M1 can be damage and reduce in milk.

THE EXPERIMENTAL RESULTS

After observing the experiments result, it conclude that the adding radioactive iodine to milk omits the aflatoxin M1 as much as the accuracy of the machine. The amount of aflatoxin M1 in the first milk sample with the volume of 17 cm^3 without iodine is measured as 0.15 ng/l. and if 1, 2, and 4 mCi are added to 17cm^3 milk, after 15 days the aflatoxin M1 level will come to 0.05 ng/l which is equal to the accuracy of measurement. And if 6 mCi is added to 17cm^3 milk, after 15 days the aflatoxin M1 amount will be less than the accuracy measurement. The amount of aflatoxin M1 reduction in iodine solvent containers and the adjacent non-iodine solvent container was equal. Therefore, we conclude that the adjacency effect have the same result when putting iodine in the container.

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Table 1: the weight percentage of cow's milk (3.5% fat) (Mansouri et al,2013)

Elements	**Weight percent**	**Elements**	**Weight percent**	**Elements**	**Weight percent**	**Elements**	**Weight percent**
Al	4.6e-07	**Co**	1.3e-09	**Mn**	4.7e-08	**Sn**	2e-09
B	6e-07	**S**	2.1e-4	**Mo**	4.2e-08	**Na**	4.3 e-04
Br	2.3e-06	**Cr**	2.8e-08	**N**	0.0102	**Ti**	4e-08
C	0.0637	**Cu**	1.3e-07	**Mg**	1 e-04	**Zn**	2.8e-06
Ca	1.1 e-03	**F**	1.5e-07	**Ni**	4e-09	**Sb**	1e-07
Cd	7e-08	**K**	1.4 e-03	**O**	0.8199	**Se**	1.5e-08
Cl	5.2e-08	**H**	0.1089	**P**	3.2 e-04	**Si**	4.4e-07
I	4e-08	**Fe**	5.7e-07	**Pb**	4e-08		

Table 2. The beta and gamma absorbed Dose in milk's aflatoxin due of iodine 131 in milk.

iodine 131 Radiation Type	Absorbed Dose(Gy)
Gamma	6.58
Beta	526000