

Assessment of hexavalent chromium in broiler chicken meat

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Abstract

Broiler chicken is considered as a major source of dietary protein. The core purpose of this present study was to determine the concentration of Chromium (VI), the harmful form of chromium, in various body parts of broilerchicken. A total of 30 chicken samples (15 large chickens and 15 small chickens) were collected from randomly selected poultry shops of Nabinagar, Dhaka, Bangladesh. Samples were prepared by wet digestion method. Then they were analyzed by atomic absorption spectrophotometer for the presence of hexavalent chromium. Our results showed that, in small chicken the lowest concentration ($0.0094\text{ppm} \pm 0.00049\text{SE}$) of Cr (VI) was found in the liver, whereas the highest concentration was quantified in the bones ($0.0466\text{ppm} \pm 0.00106\text{SE}$). In case of large chicken, minimum concentration of Cr (VI) was analyzed in head ($0.0447\text{ppm} \pm 0.00069\text{SE}$), whereas breast meat showed the maximum concentration, $0.0799\text{ppm} \pm 0.00068\text{SE}$. Consumption of healthy chicken meat can meet the need of protein as a basic nutrient and can make available at a cheaper rate to the people of all walk of life.

Keywords: Atomic absorption; Broiler Chicken; Chromium (VI); Spectrophotometry; Meat.

Introduction

Poultry meat is the main source of protein for human beings all over the world. According to WHO and FAO in Bangladesh, the consumption of meat per year is 23 kg per head in where 35.25% comes from the poultry industry [1]. The main ingredient of poultry diet is poultry feed. In the last few

years, poultry feed is made from chrome shaving dust, which is a solid waste of leather industry. In Bangladesh, only Hazaribagh tannery industries process about 220 metric tons of hide and skin per day. A ton of hides and skin is associated with the generation of approximately 600 to 1000 kg of solid waste [2]. There is a rapid increase in

consumption of chicken meat due to its less purchase cost than mutton and better nutritional value with effective health impacts than beef. In order to meet the increasing demand of chicken meat, suppliers and poultry farm owners try to streamline the augmented demand of chicken meat by uninterrupted supply [3]. To meet this increased demand, poultry farm owners buy one day chick from hatchery and that chick is provided with special type of feed which contains a small percentage of leather to provide protein nourishment. This feed enables a chick to be ready for supply to market within 45 to 50 days. Leather which is a processed animal hide, chemically collagen-based protein facilitates the rapid growth of chicken. Cr (VI) salts, K_2CrO_4 and $K_2Cr_2O_7$ are used for chrome tanning of leather. During this process, Cr (VI) stocks into leather [4]. Cr (VI) toxicity is a global problem, having genotoxic effects in human beings. Cr (VI) is one of the top sixteen toxic pollutants which is an ever-increasing threat to the environment. It is released during many industrial processes. Because of its carcinogenic characteristics for humans, it has been classified by International Agency of Research on Cancer into Group 1 and by U.S.E.P.A into Group A for causing lung cancer [5]. Due to high toxicological effects of chromium on human beings, its concentration in different food items have been examined by different scientists using different methodologies like quadrupole inductively coupled plasma-mass spectrometry with ultrasonic nebulization and atomic absorption spectroscopy [6]. Meat and meat products are important for human diet in most parts of the world. Due to the high concern about the effects of anthropogenic pollution on the ecosystems, contamination with heavy metals is a serious threat because of their toxicity, bioaccumulation and biomagnifications in the food chain. In this regard, meat of various animals has been

analyzed by different workers in various ways to determine the amount of toxic metals [7]. The main aim of this study is to analyze the concentration of Cr (VI) in various parts of chicken which is being bioaccumulated in it.

Materials and methods

Samples collection: The study was conducted at the Department of Pharmacy, Jahangirnagar University during the period of September 2019 to November 2019. From selected 3 poultry sellers of Nabinagar, Savar, Dhaka in Bangladesh a total of 30 chickens (15 healthy broiler chickens and 15 healthy layer chickens) were collected to evaluate of chromium levels. Then all samples were immediately brought to Department of Pharmacy, Jahangirnagar University.

Sample Preparation: The process of digestion is required for spectroscopic analysis. The principle is releasing of metals from solid matrix to the acid solution during the extraction process. The concentration of total heavy metals in broiler feed and meat samples were determined at the Department of Pharmacy, Jahangirnagar University. According to Rashed et al. (2016) nitric and perchloric acid digestion in 2:1 ratio was used for digestion of samples [8]. For nitric and perchloric acid digestion it is required to prepare di-acid mixture by adding 100ml nitric acid and 50ml perchloric acid to produce 150ml preparation. Approximately 1mg of sample was placed in a 250ml of digestion tube before the addition of digestion tube before the addition of 10 ml di-acid mixture. The mixture then placed on a hot plate to maintain $120^{\circ}C$ temperature until the mixture become colorless. After completing the digestion, the sample kept cool at room temperature. Then the digest was filtered through a filter paper (Whatman no.42) and the filtrate volume was made up to 50ml with distilled water. The sample was

then diluted to 100ml using deionized distilled water and preserved it plastic water container.

Determination of chromium in sample by spectroscopic analysis: The determination of chromium in extracted samples was done by using an atomic absorption spectrophotometer (AAS) (Shimadzo, AA7000, Japan). Monoelement hollow cathode lamp was employed for this determination.

Statistical analysis: Data for chromium (Cr) content of broiler meats from two category of chicken were analyzed statistically using the independent (unpaired) t- test. From this statistical test, it can be concluded that there was significant difference in chromium concentrations between chickens of two age category. Besides, one-way Analysis of variance (ANOVA) shows that different age and weight category had a significant effect on broiler meat chromium levels.

Result and discussion

The Cr concentration in collected broiler chickens are presented in Table 1 and Table 2 with the mean (\pm SE) concentration of Chromium in samples collected from Nabinagar, Savar, Dhaka, Bangladesh. Age range of large chickens are 90-120 days and small chickens are 30-90 days. All measurements are represented as mean

concentration \pm S.E. Unit of the measurement is ppm (parts per million). The ranges of Chromium concentrations in the large chicken were: Head (0.0435 – 0.0459) ppm, with a mean of 0.0447 ± 0.00069 ppm; liver (0.0591 – 0.0617) ppm, with a mean of 0.0603 ± 0.00076 ppm; Gizzard (0.0586- 0.0615), with a mean of 0.0603 ± 0.00088 ppm; bones (0.0614- 0.0632), with a mean of 0.0623 ± 0.00052 ppm, wings meat (0.0732- 0.0749), with a mean of 0.0741 ± 0.00051 ppm; breast meat (0.0789- 0.0812), with a mean of 0.0799 ± 0.00068 ppm and leg meat (0.0678- 0.0685), with a mean of 0.0682 ± 0.00023 ppm.

The result of Chromium concentrations in the various parts of small broiler chicken (head, liver, gizzard, bones, wings meat, breast meat, leg meat) ranged from (0.0094 – 0.0466), with a mean of 0.0368 ± 0.00069 ppm in the head; in the liver (0.0084- 0.0099), with a mean of 0.0094 ± 0.00049 ppm; in gizzard (0.0142-0.0162), with a mean of 0.0153 ± 0.00059 ; in bones (0.0450- 0.0486) with a mean of 0.0466 ± 0.00106 ppm; in wings meat (0.0261-0.0278) with a mean of 0.0270 ± 0.00049 ppm; in breast meat (0.0235-0.0262) with a mean of 0.0251 ± 0.00084 ppm and in leg meat (0.0317-0.0329) with a mean of 0.0324 ± 0.00036 ppm.

Table-1: Concentration of Cr (VI) in different body parts of large chicken

Chicken Type (age range)	Body Parts	Mean conc.	Mean conc. \pm S. E.
Large Chicken (90-120 days)	Head	0.0447	0.0447 ± 0.00069
	Liver	0.0603	0.0603 ± 0.00076
	Gizzard	0.0603	0.0603 ± 0.00088
	Bones	0.0623	0.0623 ± 0.00052
	Wing meat	0.0741	0.0741 ± 0.00051
	Breast meat	0.0799	0.0799 ± 0.00068
	Leg meat	0.0682	0.0682 ± 0.00023

Table-2: Concentration of Cr in different body parts of small chicken

Chicken Type (age range)	Body Parts	Mean conc.	Mean conc. \pm S. E.
Small Chicken (30-90 days)	Head	0.0368	0.0368 \pm 0.00069
	Liver	0.0094	0.0094 \pm 0.00049
	Gizzard	0.0153	0.0153 \pm 0.00059
	Bones	0.0466	0.0466 \pm 0.00106
	Wing meat	0.0270	0.0270 \pm 0.00049
	Breast meat	0.0251	0.0251 \pm 0.00084
	Leg meat	0.0324	0.0324 \pm 0.00036

In this study, all the samples have confirmed the presence of chromium (VI) though the amount is below the permissible limit recommended by WHO and CODEX STAN 193-1995 (Amendment: 2010) [9]. Samples are divided into two age ranges large chicken 90-120 days and small chickens 30-90 days. Seven different edible parts are taken as different people have preference to eat one than the other. In comparison, all the parts of large chicken have higher amount of chromium than the small ones. This may be because of chromium deposition in different parts of chicken who were fed with poultry feed, and the values are mostly increased proportionate to feeding time and age. This event is very much relatable to one study where they stated that after feeding with excess amount of chromium containing feed the chance of chromium deposition in chicken increases 6 to 76 times than the normal standard limit [10]. The excess amount of chromium easily enters the human body through the chicken meat without being destroyed by cooking, leading to the carcinogenic effects on human beings. There is another observation that among the seven body parts of small chicken the highest concentration of Cr was obtained in bones with a value of (0.0466 ppm) while the least was in liver (0.0094 ppm). Which can be represented thus: Bones> Head> Leg Meat> Wings Meat> Breast Meat> Gizzard> liver. And in larger chicken the organ with the highest concentration was the breast

meat while head had the lowest concentration. However, concentrations can be expressed as Breast Meat> Wings Meat> Leg Meat> Bones> Liver= Gizzard> Head. This study is also related to our study where the two highly concentrated organs are bones and breast meat in small and large chicken respectively.

Conclusion

The results of this study clearly indicate that broilers raised with commercial feed have significant concentrations of hexavalent chromium. Albeit chromium concentrations were below the permissible FAO/ WHO levels, chicken meat should not be consumed excessively on a regular basis. It is a field of thorough analysis that in spite of having clear evidence about hexavalent chromium's carcinogenicity, there is not much evidence of public ailment in this regard.

Conflict of Interest

The authors declare no conflict of interest.

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