Estimation of Chromium (VI) in various body parts of Local Chicken

[1]TARIQ MAHMUD*,[1]RABIA REHMAN, [2]SAKHAWAT ALI, [1]JAMIL ANWAR,
[3]AADIL ABBAS, [4]MUHAMMAD FAROOQ AND [1]ADNAN ALI
[1]*Institute of Chemistry, University of the Punjab, Lahore, Pakistan.*
[2]*PCSIR Labs, Ferozepur Road, Lahore, Pakistan.*
[3]*Department of Chemistry, University of Gujrat, Gujrat, Pakistan.*
[4]*Department of Statistics, University of Gujrat, Gujrat, Pakistan.*
tariqm06@yahoo.co.uk*

(Received on 8th June 2010, accepted in revised form 21st September 2010)

Summary: Chicken is a common type of meat source in our food. It is fed with the feed containing small pieces of leather having Cr (VI) which persisted in it during chrome tanning process. The core purpose of present study was to determine the concentration of Cr (VI) in different body parts of chicken like leg, arm, head, heart, liver and bone. Estimation of Cr (VI) was done by preparing the sample solutions after ashing and digestion with nitric acid, by atomic absorption spectrophotometer. The results depicted that the meat part of leg had higher mean concentration (1.266 mg/kg) with 0.037 mg/kg standard error while the lowest average concentration was found in arm (0.233 mg/kg) with standard error as 0.019 mg/kg. In case of bones, the maximum mean concentration was found in head (1.433 mg/kg) with standard error as 0.670 mg/kg. The concentration of Cr (VI) was not found similar in meat and bones of chicken by employing Kruskal Wallis Test.

Introduction

Chicken is an important part of cooking menu. 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 [1]. In Pakistan, 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 in Pakistan. During this process, Cr (VI) stocks into leather. [2].

Cr (VI) 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 [3-5]. In an organism's cells, the important reason of the mutagenic activity of Cr (VI) is its oxidation properties. It can easily pass through the cellular membrane and oxidizes its constituents which results in metabolic reduction, first to meta stable Cr (V), then to Cr (III). Cr (III) binds to proteins and creates haptens which trigger immune system reaction. Migration of chromium metabolite complexes to nuclei and their interaction with DNA causes negative effect [6, 7]. Chrome sensitivity becomes fairly persistent, even contact with chromate dyes, textiles or wearing of chromate tanned leather shoes can cause or exacerbate contact dermatitis. There is sufficient evidence in humans for the carcinogenicity of Cr (VI) compounds as encountered in the chromate production, chromate pigment production and chrome plating industries. The damage is caused by hydroxyl radicals, produced during re-oxidation of Cr (V) by hydrogen peroxide molecules in the cell [5, 8]. The mechanism of cancer formation caused by Cr (VI) is not known for certain; however, it has been postulated that Cr (VI) binds to deoxyribonucleic acid (DNA), therefore causing gene replication, repair, and duplication [9]. It also causes the adverse effects on kidneys and liver. Inhalation exposure to Cr (VI) may results in additional adverse effects or respiratory system may affect the immune system [10]. Necrosis of the kidneys is caused by Cr (VI) which starts with tubular necrosis as well as diffuse necrosis of the liver [11].

Chromium based chemicals are used for chrome tanning, a widely used process for turning a skin into bluish-white-colored leather that can be stored for a long time. Toxic effects of Cr (VI) may include hepato-toxicity; mutagenesis leading to post implantation loss and decreased weight and carcinogenesis; impaired steroid genesis leading to

*To whom all correspondence should be addressed.

impaired spermatogenesis ovarian dysfunction, oxidation of hemoglobin, human lymphocyte apoptosis and decreased interleukin-6 levels [12-20].

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 [21-24]. Meat and meat products are important for human diet in many 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 [25, 26]. 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.

Result and Discussion

The concentration of Cr (VI) in various body parts of chicken meat were shown in Table-1. The average minimum concentration was found in the arm (0.200 mg/kg). The mean concentration was approximately same in the neck and liver parts; however concentration level in these parts was higher. The results also depicted that leg shows higher mean concentrations (1.2657 mg/kg) with 0.0375 mg/kg standard error from rest of the parts. Second highest average concentration was found in heart (1.1442 mg/kg) with standard error 0.7624 mg/kg. Furthermore, this concentration is highly consistent in the leg as the coefficient of variation was minimum in this part (5.1363) while it was highly inconsistent in heart of chicken (Coefficient of Variance =136.3494). The liver was also found inconsistent regarding the concentration of Cr (VI).

Table-1: Concentration of Cr (VI) in meat parts of poultry (mg/kg).

Descriptive Statistics	Body Parts of Chicken						
	Sternum	Leg	Arm	Gizzard	Neck	Heart	Liver
Minimum	**0.670**	**1.200**	**0.200**	**0.800**	**0.330**	**0.300**	**0.330**
Maximum	**0.800**	**1.330**	**0.270**	**1.070**	**0.600**	**2.670**	**0.610**
Mean	**0.734**	**1.266**	**0.233**	**0.933**	**0.489**	**1.144**	**0.415**
Standard Deviation	**0.065**	**0.065**	**0.033**	**0.133**	**0.139**	**1.321**	**0.331**
***C.V**	**8.853**	**5.136**	**14.27**	**14.28**	**28.43**	**86.62**	**79.68**
Standard Error	**0.037**	**0.037**	**0.019**	**0.077**	**0.080**	**0.762**	**0.191**

* Coefficient of Variance

The concentration of Cr (VI) in various bones of chickens was also investigated and presented in Table-2. The maximum concentration of Cr (VI) was found in head (1.433mg/kg) with standard error as 0.670 mg/kg followed by arm, neck, leg and chest cage, where chest cage shows presence of minimum average as 0.323 mg/kg with 0.302 mg/kg standard error.

Table-2: Concentration of Cr (VI) in bones of chicken (mg/kg).

Descriptive Statistics	Bones of chicken				
	Chest Cage	Neck	Leg	Head	Arm
Minimum	**0.267**	**0.300**	**0.369**	**1.366**	**0.370**
Maximum	**0.370**	**0.476**	**0.377**	**1.500**	**0.415**
Mean	**0.323**	**0.373**	**0.340**	**1.433**	**0.397**
Standard Deviation	**0.524**	**0.918**	**0.409**	**0.670**	**0.241**
C.V*	**61.69**	**40.63**	**83.27**	**213.9**	**165.24**
Standard Error	**0.302**	**0.530**	**0.024**	**0.387**	**0.139**

* Coefficient of Variance

A non-parameter alternate of ANOVA, K-Sample Kruskal Wallis test was used to test the equality of several population averages (Table-3). This non-parametric alternate is used when the assumptions of ANOVA are violated.

Table-3: K- Sample Kruskal Wallis Test for meat and bones of chicken.

Statistical Tests	Meat Parts of chicken	Bones of chicken
Chi-Square Statistic	**12.83**	**12.83**
Degree of Freedom	**6.0**	**6.0**
Monte Carlo Significance(p-value)	**0.014**	**0.026**
Exact Significance	**0.021**	**0.029**

One of the assumptions was normality of the concentrations of Cr (VI) for all meat and bones, which was tested by using Kolmogrov-Smirnove (KS) test. The exact level of significance for KS was computed using exact test and Monte Carlo based test. The results showed that the concentrations of Cr (VI) for all meat parts and bones was normal ($p>0.05$). The second assumption of equality of variance was violated as $p<0.05$, shown by Levene test of homogeneity of variances [27-30]. Failure of this assumption directs to use Kruskal Wallis Test. The results given in Table-3 showed that the average concentration of Cr (VI) was significantly different, both in meat parts ($p<0.05$) and bones ($p<0.05$). However, in the meat parts it differed more as compared to bones regarding average concentration of Cr (VI).The high concentration of Cr (VI) found in various parts of chicken is an alarming situation. Government of Pakistan should make solid policies to ensure the Cr (VI) free feed for poultry industry.

Experimental

Materials

During this study, all glassware and apparatus were washed and rinsed with deionized water. The reagents used were $K_2Cr_2O_7$ salt (RDH-Germany) and nitric acid (RDH-Germany). Meat and bones of chicken were taken from local shops of poultry from Barkat market, Garden Town Lahore.

Preparation of Standard Solutions of Cr (VI)

A Stock solution of Cr (VI) was obtained by dissolving 0.29 g of $K_2Cr_2O_7$ salt (RDH-Germany) in 1000 mL of distilled water to form 100 ppm solution. Then 2, 4, 6, 8, 10 ml from 100 ppm solution were taken and diluted up to 100 mL in separate measuring flasks with deionized water to form 2, 4, 6, 8, 10 ppm solutions, respectively. The absorptions of these solutions were taken by atomic absorption spectrophotometer (Perkin Elmer AAnalyst 100) to make calibration curve and to evaluate the concentration of Cr (VI) in different samples.

Preparation of Sample Solutions

Different poultry meat parts and bones such as leg, arm, head, heart, liver, back bone, chest cage, sternum, gizzard etc, were subjected for the process of ash formation in muffle furnace separately. The ash formed was dissolved in concentrated nitric acid and some distilled water was added. All these samples were filtered off in different beakers with sintered glass crucible and filtrates were boiled. The filtrates were transferred in 100 mL volumetric flasks and diluted up to the mark with deionized water [31].

All these samples were subjected for analysis to atomic absorption spectrophotometer (Perkin Elmer AAnalyst 100).

Conclusion

The feed given to poultry industry is rich in small pieces of leather that contains Cr (VI) during chrome tanning process of hide. Very high concentration of Cr (VI) was found in all meat parts of chicken especially in leg part which is main item of fast food [2]. The Cr (VI) becomes the part of human body directly through chromium concentrated chicken meat. The concentration of Cr (VI) was also found in bones of chicken body, which are usually used to make chicken stock and soup. The high concentration of chromium in chicken is an alarming situation regarding the health of the people of Pakistan. It is our recommendation that the Government of Pakistan should ensure the chromium free feed for the poultry industry.

References

1. NRC, *Nutrient Requirements of Poultry*, The National Academies Press Washington, DC. 9th revised Edition (1994).
2. *Polish Recommendation of Poultry Nutrition*, Instytut Fizjologii i Kywienia Zwierzat PAN, Jabłonna, Edition IV (2005).
3. J.L. Gardea-Torresdey, K.J. Tiemann, V. Armendariz, L. Bess-Oberto, R.R. Chianelli, J. Rios, J.G. Parsons, G. Gamez, *Journal of Hazardous Material*, **80**, 175 (2000).
4. U.S. Environmental Protection Agency. *Integrated Risk Information System (IRIS) on Chromium VI*. National Center for Environmental Assessment, Office of Research and Development, Washington, DC. (1999).
5. International Agency for Research Monographs on the *"Evaluation of Carcinogenic Risks to Humans. Chromium, Nickel and Welding"* International Agency for Research on Cancer, Lyon. **49**, 49 (1990).
6. A. Bielicka, I. Bojanowska, A. Wisniewski, *Polish Journal of Environmental Studies*, **14**, 5 (2005).
7. M. C. Golonka, *Polyhedron*, **15**, 3667 (1995).
8. A. Hartwig, *Toxicology Letters*, **102-103**, 235 (1998).
9. M. J. Kendrick, M. T. May, M. J. Plishka, K. D. Robinson, *Metals in biological systems*, Ellis Horwood Ltd, Chichester, UK, 183 (1992).
10. A. Huma, S. Yasmeen, A. Yaqub, Z. Ajab, M. Junaid, M. Siddique, R. Farooq, S. A. Malik, *Journal of Toxicological Sciences*, **33**, 415 (2008).
11. D. B. Kaufman, W. DiNicola, R. McIntosh, *American Journal of Diseases of Children*, **119**, 374 (1970).
12. S. Ueno, N. Susa, Y. Furukawa, M. Sugiyama, *Toxicology and Applied Pharmacology*, **135**, 165 (1995).
13. M. Junaid, R. Murthy, D. Saxena, Veterinary & *Human Toxicology*, **37**, 320 (1995).
14. A. Chowdhury, *Indian Journal of Experimental Biology*, **33**, 480 (1995).
15. Y. Y. Lu, J. L. Yang, *Journal of Cellular Biochemistry*, **57**, 655 (1995).
16. R. Rajaram, B. U. Nair, T. Ramasami, *Biochemical and Biophysical Research Communications*, **210**, 434 (1995).
17. U. Rafique, A. Ashraf, A. K. Khan, S. Nasreen, R. Rashid and Q. Mahmood, *Journal of the Chemical Society of Pakistan*, **32**, 644 (2010).
18. M. Saeed, N. Muhammad, H. Khan, S. A. Khan, *Journal of the Chemical Society of Pakistan*, **32**, 471 (2010)
19. S. N. Zakir, I. Ihsanullah, M. T. Shah and Z. Iqbal, *Journal of the Chemical Society of Pakistan*, **31**, 757 (2009).

20. S. Naeem, U. Zafar, A. Altaf and A. Inayat, *Journal of the Chemical Society of Pakistan*, **31**, 379 (2009).
21. F. Cubadda, S.Giovannangeli, F. Iosi, A. Raggi, P. Stacchini, *Food Chemistry*, **81**, 463 (2003).
22. M. S. Bratakos, E. S. Lazos, S. M. Bratakos, *The Science of Total Environment*, **290**, 47 (2002).
23. U. Tinggi, C. Reilly, C. Patterson, *Food Chemistry*, **60**, 123 (1997).
24. O. D. Uluozlu, M. Tuzen, M. Soylak, *Food and Chemical Toxicology*, **47**, 2601 (2009)
25. D. Demirezen, K. Uruç, *Meat Science*, **74**, 255 (2006).
26. D. Bohrer, E. Becker, P. C. do Nascimento, M. Dessuy, L. M. de Carvalho, *Food Chemistry*, **104**, 868 (2007).
27. D. J. Sheskin, *Hand Book of Parametric and Nonparametric Statistical Procedures*, 3rd Edition, Chapman & Hall, Boca Raton (2004).
28. E. B. Manoukian, Mathematic *Non-parametric Statistics*, Gordon and Breach Science Publisher, New York (1986).
29. P. R. Kinnear, C. D. Gray, *SPSS 12 made Simple*, Psychology Press, New York (2004).
30. A. Field, *Discovering Statistics Using SPSS*, 3rd Edition, Sage Publications London (2009).
31. M. Tuzen, *Food Chemistry*, **80**, 119 (2003).