Daily consumption of commercial chicken feed and meat lead to alterations in serum cholesterol and steroidal sex hormones in female rats

Saara Ahmad[1], Iftikhar Ahmed[2], Saida Haider[3], Zehra Batool[3] and Saad Bilal Ahmed[4]
[1]Department of Biological and Biomedical Sciences, The Aga Khan University, Karachi, Pakistan
[2]Department of Biochemistry, Baqai Medical University, Karachi, Pakistan
[3]Neurochemistry and Biochemical Neuropharmacology Research Unit, Department of Biochemistry, University of Karachi, Karachi, Pakistan
[4]Department of Geriatrics, Monash University, Melbourne, Australia

Abstract: Poultry consumption is increased worldwide owing to better taste, easy availability and low cost. The present study was designed to investigate the effects of the chicken feed, conventional chicken meat and organic chicken meat on the % growth rate, serum cholesterol, progesterone, testosterone and estrogen levels in female rats. Hundred female Albino Wistar rats were randomly assigned to four groups (n=25). Group I was control rats fed on standard chow, group II treated with commercial chicken feed, group III rats fed with conventional chicken meat and group IV with organic chicken meat for a period of 6 weeks. % Growth rate, serum cholesterol, progesterone, testosterone and estrogen levels were estimated after the treatment. The present study showed significant increase in growth rate, serum cholesterol levels and imbalance in serum steroidal hormone levels. It is therefore, suggested from the present study that the intake of commercial chicken feed and commercial chicken meat may be the potential cause of development of polycystic ovary syndrome in females due to steroid hormonal imbalance.

Keywords: conventional chicken meat, organic chicken meat, chicken feed, serum progesterone levels, serum cholesterol levels.

INTRODUCTION

In Pakistan chicken consumption is most abundant nowadays (Ahmad *et al*., 2016). Different yields of the chicken meat are available in the market place. The mundane daily consumption of the chicken meat has exceeded higher than any other meat product comprising of fish and red meat (Cerqueira *et al*., 2016). To meet the high chicken demand and supply more and more poultry farms are created to encourage poultry production all over the nation. Rearing of hens is stimulated at domestic levels where small chicken pens are kept on the backyards (Cerqueira *et al*., 2016). The chicken generally takes three months time to grow into a broiler, the size adequate for consumption (Ahmad *et al*., 2016). The poultry industry however nowadays uses feed for the chickens that facilitate them to grow to a complete size in just one and a half months (Cinar *et al*., 2012). The feed given to them is augmented with many nutritional and non-nutritional products especially steroids, antibiotics, minerals, cholesterol and arsenic (Coelingh *et al*., 2017). Feed is used with determination for the better growth as well as performance of the chickens. The constituents of the chicken feed are stated to cause enhanced taste of chicken meat with amplified meat size. The meat provides human beings with vital macromolecules of proteins and fats. However, the feed distillate containing certain harmful substances mainly roxersone, oyster shells from contaminated waters (for calcium supplementation) and antibiotics are imparted to fed chicken meat and may bring harmful effects to the individuals consuming such chicken meat (Cinar *et al*., 2012). The chicken meat is also known to deliver cholesterol to humans that were fed to chickens in feed. The amplified cholesterol levels consumed through meat may not only cause obesity but also consequence in the excessive production of the steroidal hormones (Cranney, 2016). The notably indispensable steroidal sex hormones are estrogens, progesterone and testosterone that are produced in testes and ovaries of the body (Fanta, 2013).

Progesterone is formed in both males and females (Gonzalez-Moran, 2015). The key function of the progesterone in females is development of female secondary sexual characteristics such as breasts, uterine endometrium, regulation of the menstrual cycle, production of testosterone and formation of estrogens in the body (Hamano and Kurimoto, 2016). Progesterone eventually converts to testosterone and then in the presence of aromatase enzyme to estrogens (Daneasa *et al*., 2016). The functions of these subsequent hormones are to contribute in maturation of secondary sexual characteristics as well as maintenance of the integrity of the male and female reproductive systems (Heidelbaugh, 2016).

**Corresponding author:* e-mail: saara_ahmad@hotmail.com

Previous studies show that in female rats the estrus cycle is short duration of just 5 days (Hu *et al*., 2012). The alteration of these steroidal sex hormone levels is identified to disturb follicular growth and development, oocyte discharge and sexual receptivity to the opposite sex (Jiralerspong and Goodwin, 2016). The result may be in prolongation of the reproductive cycles through anovulation or lack of implantation subsequently leading to infertility (Lopez and Tena-Sempere, 2016). Studies show that disturbed levels of progesterone, testosterone and estrogens may also result in weight gain and obesity, insulin resistance leading to type II diabetes, ovarian hyper stimulation syndrome and an ovulatory cycles leading to the formation of cysts in the ovaries. Other changes subsequent may range from abnormal morphology of the uterine endometrium to development of breast and ovarian cancers in females (Marzec *et al*., 2016).

Research shows that conventional chicken products may alter these hormonal levels in the body (Palioura and Diamanti-Kandarakis, 2013). The present study was therefore designed to observe the effects of administration of conventional chicken meat and organic chicken meat on the serum cholesterol, progesterone, testosterone and estrogen levels in female rats with their net effect of growth rate.

MATERIALS AND METHODS

Animals

Hundred female Albino Wistar rats (90-110g) were purchased from Dow University of Health Science, OJHA campus, Karachi. Pakistan. Three rats were housed in one cage for 12 h day and night cycle with ambient room temperature of 22±2°C. The experimental protocol was approved by the ethical committee of Baqai Medical University (BMU/BIOCHEM/19) and performed in line with National Institute of Health Guide for Care and Use of Laboratory Animals (Publication No. 85-23, revised 1985).

Reagent and chemicals

Total cholesterol assay kit and enzyme immunoassay assay kits for progesterone, testosterone and estrogen estimation were purchased from Biocheck, Inc. USA.

Experimental protocol

Animals were divided into four groups (n=25). Group I and group II were treated with standard rat chow and chicken feed, respectively. Commercial chicken and organic chicken boneless meat in the raw form were given to group III and group IV respectively. Standard rat chow contained wheat flour (400g), gram flour (171g), barley flour (171g), corn flour (100g), vegetable oil (50g), milk powder (100g), vitamin mixture (2.5g), iodized salt (NaCl; 5.5g). Chicken feed which is used for the broiler chicken at the poultry farms and commercial chicken meat were purchased from the local market of Karachi, Pakistan. Organic chicken was given *ad libitum* mixture of grains composing wheat, barley, soy and maize. No additives added nor feed milled. The treatment was continued for a period of six weeks. Body weight was measured before and after the experiment and % growth rate was calculated by using the formula [(final weight/initial weight) × 100]. Blood was collected through cardiac puncture for the estimation of serum cholesterol, progesterone, testosterone and estrogen levels using Elisa kit method.

STATISTICAL ANALYSIS

Data was analyzed by one-way ANOVA using SPSS version 20.0. Individual comparison were made by Tukeys HSD test; p values <0.05 were considered significant.

RESULTS

% Growth rate

Fig. 1 shows the effects of the intake of rat chow, chicken feed, conventional chicken meat and organic chicken meat on the weight gain of the rat groups. Data was analyzed by one way ANOVA ($F_{(3,\ 96)}$ =242.16.39, p<0.01) and post-hoc Tukeys HSD test revealed a significant increase in the % growth rate (p<0.01) of groups II and III while a significant decrease in the % growth rate was seen (p<0.01) in group IV rats as compared to that of group I control rats.

Serum cholesterol levels

Fig. 2 shows the serum cholesterol, progesterone, testosterone and estrogen levels of the rats of the four groups. One way ANOVA ($F_{(3,\ 96)}$=130.53, p<0.01) and post-hoc Tukeys HSD test revealed a significant increase in serum cholesterol levels of group II and III rats when compared with group I and IV rats (p<0.01).

Serum progesterone levels

The analysis of data of serum progesterone levels with the one-way ANOVA ($F_{(3,\ 96)}$=39.203, p<0.01) and post-hoc Tukeys HSD test revealed a significant decrease in the serum progesterone levels in group II and III when compared with group I and IV rats (p<0.01; fig. 2).

Serum testosterone levels

Daily consumption of chicken feed and meat significantly altered serum levels of testosterone ($F_{(3,\ 96)}$=143.21, p<0.01). Post-hoc analysis by Tukeys HSD test revealed significant increase in testosterone levels in group II and III as compared to group I and IV (p<0.01).

Serum estrogen levels

The levels of estrogen were also significantly changed

following the consumption of different diet ($F_{(3, 96)}$=29.31, p<0.01). Post-hoc analysis by Tukeys HSD test showed significant increase in estrogen levels in group II and III as compared to group I and IV (p<0.01).

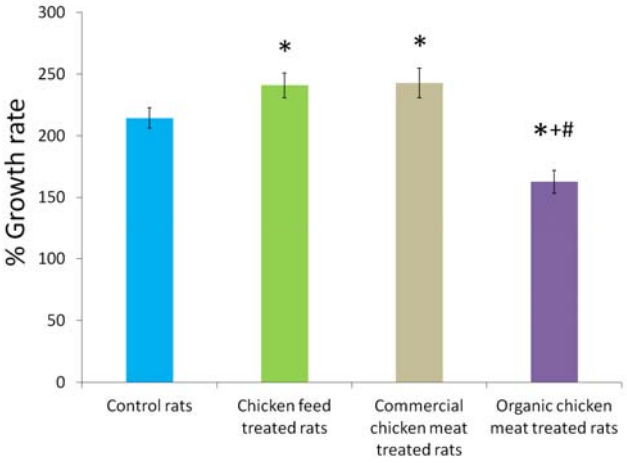

Fig. 1: Effects of different diets on the % growth rate of the rats recruited in the study. Values are mean ±SD (n=25). Significant difference by Tukeys HSD test; *p<0.01 vs control group fed with rat chow; +p<0.01 vs chicken feed treated rats; #p<0.01 vs commercial chicken meat treated group. % Growth rate was calculated by using the formula = (Body weight after the treatment/ body weight before the treatment) × 100.

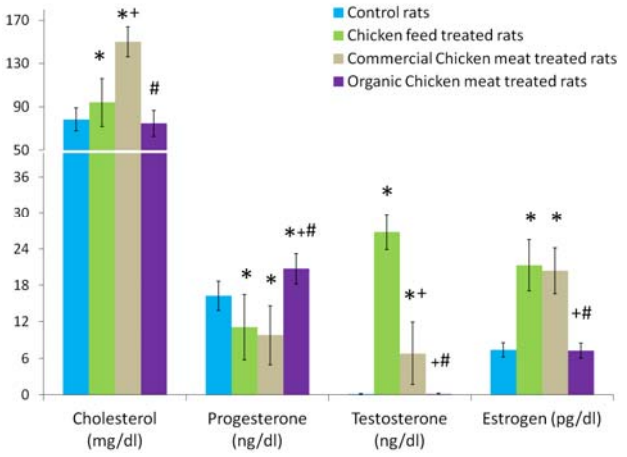

Fig. 2: Effects of different diets on serum cholesterol, progesterone, testosterone and estrogen levels. Values are mean±SD (n=25). Significant difference by Tukeys HSD test; *p<0.01 vs control group fed with rat chow; +p<0.01 vs chicken feed treated rats; #p<0.01 vs commercial chicken meat treated group.

DISCUSSION

In Pakistan daily ingestion of the chicken meat has surpassed red meat products available in the market. This augmented consumption of chicken meat may bring damaging effects on human health. Chickens are domestically nurtured animals and are frequently consumed in Pakistan. The chief products of chicken taken in account for eggs and meat. Chicken meat is primed as food in a multiplicity of ways, varying by states and traditions in Pakistan. The greater frequency of chicken consumption is due to their complete edibility and much ease in raising them. This has enabled the populace to overtake chicken meat consumption to that of beef and mutton. The present study was done to discern the effects of conventional chicken meat and organic chicken meat on the serum progesterone and its conversion to testosterone and estrogens in the body. Chicken meat as cheap, certainly available and measured rich in dietary nutrients (Psifidi *et al*., 2016) make it oblivious of its dietetic facts in terms of consuming more fats and cholesterol than proteins. This accordingly increases weight leading to obesity. It was reported previously that meat of the chicken fed on commercially available chicken feed contains large ration of proteins, fats and cholesterol than proteins, hence, providing precursors for the synthesis of fat and cholesterol in the body result in enhanced body weight leading to obesity (Qiao *et al*., 2015). This can be accredited to the recent increase in the rate of obesity in the Pakistani population consuming chicken meat.

It was observed in the present study that intake of conventional chicken meat (available in the market) for six weeks as a regular diet significantly decreased the serum progesterone levels in rats as compared to the rats fed on rat chow and organic chicken meat. This may be due to the disruption in the pituitary ovarian axis leading to diminished production of progesterone which is considered as a friendly hormone for the female body (Tsutsumi and Webster, 2009). The testosterone and estrogen levels were also significantly increased in chicken feed and commercial chicken meat treated rats as compared to controls and organic chicken meat treated rats. Testosterone is the most potent circulating androgen. Females with polycystic ovary syndrome (PCOS) have high levels of testosterone as compared to ovulatory and non-hirsute women (Rosencrantz *et al*., 2011). In this study the cholesterol levels were significantly increased following the administration of chicken feed and commercial chicken meat and study showed that amplified cholesterol levels assist the steroidal hormones synthesis in the body (Fanta, 2013).

Henceforth cholesterol and fat intake via the commercial poultry products may result in more cholesterol formation and fat storage, in the body as adipose tissue, ensuing increased growth and hormone synthesis (Cinar *et al*., 2012). All these factors may eventually result in the formation of the PCOS in the females. As studies show parent hormone progesterone and its later on conversion to testosterone play a vital role in secondary sexual characteristics development and in sustaining integrity of reproductive cycles in organisms (Qiao *et al*., 2015; Wang *et al*., 2011). Research shows that irregularities in

synthesis of theses hormones production may lead to altered development of secondary sexual characteristics and inability to attain sexual maturation (Wang *et al*., 2011). This may direct to inability to procure off springs. Previous study reported that alterations in testosterone, estrogens and progesterone levels may results in prolongation in estrus cycles that may result in irregularity of reproductive cycles leading to infertility (Jiralerspong and Goodwin, 2016). Likewise, studies show that in human females disturbed steroidal hormonal levels may also cause irregular and anovulatory cycles (Heidelbaugh, 2016). The present experiment suggested that frequent consumption of chicken meat reasons obesity and altered steroidal hormonal levels in females. Obesity and oscillating progesterone levels forming testosterone and estrogens may result in cystic formations in ovaries, hyperlipidemias, insulin resistance, hypertension and diabetes (Milicevic *et al*., 2014). Amplified estrogens in body may become source of proliferation of cells in uterus and breast (Mushtaq *et al*., 2013). Proliferation of the uterine lining with no proclamation of the follicle may lead to anovulatory cycle and cystic conversions of these follicles (Mehta *et al*., 2016). The cessation of the release of ovum may cause irregularities in menstrual cycle with difficulty in getting pregnant.

Present study enlightens that variation in steroidal hormone synthesis in rats fed on the conventional chicken meat may be characteristic of fat and the cholesterol rich diet that broilers receive in addition to building up of their concentrates in their flesh. Upon consumption of such meat, it is anticipated that augmented production of cholesterol with synthesis of steroid hormones take place in human body. As the chosen edible at the present time, chicken meat as well as its consumption has a compelling effect on poultry manufacturing in terms of more demand and supply. In order to meet these requirements the commercially available chicken feed with various dietary additions like steroidal hormones, fats, antibiotics totaling to the regular feed constituents like wheat and grains are marketed for hastened growth of early days chickens leaving the feed constituents in their flesh making spiteful effects on human health on consumption. This was hence established that the dietary patterns currently are one of the major cause of obesity, PCOS, diabetes plus many health associated maladies linked to insulin resistance, hyperlipidemia and hormonal imbalances (Cinar *et al*., 2012; Mushtaq *et al*., 2013; Cranney, 2016). This study is a forthcoming study for the human model depicting the changes that may arise upon ingestion of the commercially available chicken meat on interplay of hormones of reproduction that may result in infertility.

CONCLUSION

Conventional chicken meat caused decrease in serum progesterone levels and increased testosterone and estrogen levels in addition to increased growth rate and cholesterol levels which may be associated with risk for the development of PCOS, obesity in females resulting in the development of other health related concerns.

REFERENCES

Ahmad S, Omm-e-Hany, Ahmed I, Ahmed SA, Alamgir A and Neelam A (2016). Potential effect of chicken boneless meat on the body weight and serum cholesterol levels of the female albino wister rats: In direct human prospective studies. *Am. Eurasian J. Agric. Environ. Sci.*, **16**: 466-469.

Cerqueira NM, Oliveira EF, Gesto DS, Santos-Martins D, Moreira C, Moorthy HN, Ramos MJ and Fernandes PA (2016). Cholesterol biosynthesis: A mechanistic overview. *Biochemistry*, **55**: 5483-5506.

Cinar N, Harmanci A, Demir B and Yildiz BO (2012). Effect of an oral contraceptive on emotional distress, anxiety and depression of women with polycystic ovary syndrome: A prospective study. *Hum. Reprod*., **6**: 1840-1845.

Coelingh Bennink HJ, Verhoeven C, Dutman AE and Thijssen J (2017). The use of high-dose estrogens for the treatment of breast cancer. *Maturitas*, **95**: 11-23.

Cranney S (2016). The theoretical potential for selection on determinants of fertility to cause aggregate fertility increases in human populations. *Biodemography Soc. Biol.*, **62**: 275-280.

Daneasa A, Cucolas C, Lenghel LM, Olteanu D, Orasan R, Filip GA (2016). Letrozole vs estradiol valerate induced PCOS in rats: Glycemic, oxidative and inflammatory status assessment. *Reproduction*, **151**: 401-409.

Fanta M (2013). Is polycystic ovary syndrome, a state of relative estrogen excess, a real risk factor for estrogen-dependant malignancies? *Gynecol. Endocrinol.*, **29**: 145-147.

Gonzalez-Moran MG (2015). Immunohistochemical localization of progesterone receptor isoforms and estrogen receptor alpha in the chicken oviduct magnum during development. *Acta. Histochem.*, **117**: 681-687.

Hamano Y and Kurimoto Y (2016). Effects of acetylated wood powder on growth performance, hepatic and muscular free amino acid profiles and inosine 5'-monophosphate concentration of breast meat in broiler chickens. *Br. Poult. Sci.*, **57**: 643-654.

Heidelbaugh JJ (2016). Endocrinology Update: Hirsutism. *FP Essent.*, **451**: 17-24.

Hu C, He M, Chen B and Hu B (2012). Determination of estrogens in pork and chicken samples by stir bar sorptive extraction combined with high-performance liquid chromatography-ultraviolet detection. *J. Agric. Food. Chem.*, **60**: 10494-10500.

Jiralerspong S and Goodwin PJ (2016). Obesity and breast cancer prognosis: Evidence, challenges and opportunities. *J. Clin. Oncol.*, **34**: 4203-4216.

Lopez M, Tena-Sempere M (2016). Estradiol and brown fat. Best. *Pract. Res. Clin. Endocrinol. Metab*., **30**: 527-536.

Marzec ME, Wojtysiak D, Połtowicz K, Nowak J and Pedrys R (2016). Study of cholesterol and vitamin E levels in broiler meat from different feeding regimens by TOF-SIMS. *Biointerphases*., **11**: 02A326.

Mehta RV, Malcom PJ and Chang RJ (2016). The effect of androgen blockade on granulosa cell estradiol production after follicle-stimulating hormone stimulation in women with polycystic ovary syndrome. *J. Clin. Endocrinol. Metab*., **91**: 3503-3506.

Milicevic D, Vranic D, Masic Z, Parunovic N, Trbovic D, Nedeljkovic-Trailovic J and Petrovic Z (2014). The role of total fats, saturated/unsaturated fatty acids and cholesterol content in chicken meat as cardiovascular risk factors. *Lipids. Health. Dis*., **13**: 42.

Mushtaq MM, Pasha TN, Akram M, Mushtaq T, Parvin R, Choi HC, Hwangbo J and Kim JH (2013). Growth performance, carcass characteristics and plasma mineral chemistry as affected by dietary chloride and chloride salts fed to broiler chickens reared under phase feeding system. *Asian-Australas J. Anim. Sci*., **26**: 845-855.

Palioura E and Diamanti-Kandarakis E (2013). Industrial endocrine disruptors and polycystic ovary syndrome. *J. Endocrinol. Invest*, **36**: 1105-1111.

Psifidi A, Banos G, Matika O, Desta TT, Bettridge J, Hume DA, Dessie T, Christley R, Wigley P, Hanotte O and Kaiser P (2016). Genome-wide association studies of immune, disease and production traits in indigenous chicken ecotypes. *Genet. Sel. Evol.*, **48**: 74.

Qiao L, Gan N, Wang J, Gao H, Hu F, Wang H and Li T (2015). Novel molecularly imprinted stir bar sorptive extraction based on an 8-electrode array for preconcentration of trace exogenous estrogens in meat. *Anal. Chim. Acta.*, **853**: 342-350.

Rosencrantz MA, Coffler MS, Haggan A, Duke KB, Donohue MC, Shayya RF, Su HI and Chang RJ (2011). Clinical evidence for predominance of delta-5 steroid production in women with polycystic ovary syndrome. *J. Clin. Endocrinol. Metab.*, **96**: 1106.

Tsutsumi R and Webster NJ (2009). GnRH pulsatility, the pituitary response and reproductive dysfunction. *Endocr J.,* **56**: 729-737.

Wang S1, Li Y, Wu X, Ding M, Yuan L, Wang R, Wen T, Zhang J, Chen L, Zhou X and Li F (2011). Construction of uniformly sized pseudo template imprinted polymers coupled with HPLC-UV for the selective extraction and determination of trace estrogens in chicken tissue samples. *J. Hazard. Mater*, **28**: 1513-1519.