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Hormonal residues in chicken and cattle meat: A risk threat the present and future consumer health

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Highlights

- Estradiol, progesterone, and testosterone residues were estimated in chicken and cattle meat in Assiut city, Egypt.
- An enzyme-linked immunosorbent assay (ELISA) was used to measure the previous hormonal residues.
- The estimated daily intake and the hazard index indicated the risk of estradiol and testosterone residues to human health.
- Continuous screening for these hormonal residues in meat is essential for consumers' safety and security.

Abstract

The study was designed to determine some hormonal residues (estradiol, progesterone, and testosterone) in chicken and cattle meat as well as assess the risk of these residues for adult and child consumer health. A total of 92 chicken meat samples were collected from four different chicken farm sales outlets, and 56 cattle meat samples from two brands were collected from markets through 2022 in Assiut City, Egypt. An enzyme-linked immunosorbant assay (ELISA) was used to measure the hormonal residues. Results showed that the estimated daily intake (EDI) of estradiol exceeded acceptable daily intakes (ADIs) in all analyzed samples except four chicken farm meat samples for adults only, which were below 0.05 μg/kg bw, and the hazard index (HI) of estradiol and testosterone residues for adults and children exceeded 1 in all examined samples of the study. The U.S. Food and Drug Administration (FDA) set safe limits for these anabolic hormones to ensure high-food-quality and quantity for humans, but in Egypt, monitoring and assessment of hormonal residues in food became very urgent as no safe limits have been set till now.

Introduction

Chicken and cattle meat act as an important part of the human diet in different societies, and they provide essential nutrients that cannot be easily obtained through other sources (Byers et al., 2001). The demand for nutritious food, especially food of livestock origin has increased, which enhances the usage of growth promoters by producers as a trial to meet populations needs with high yield production in a short time (Sans and Combris, 2015).

All over the world, there are different sources of meat, which includes animals, poultry and fish. According to *FAO* reports, annual Egyptian meat consumption per capita was 30.47 kg in 2013 (Africa Sustainable Livestock 2050 (ASL), 2017) and decrease to 26.29 kg in 2020 as Corona crisis.

Beef meat was produced with 310.6 thousand tons in Egypt through 2020 and it was the highest produced one in red meat sources followed with buffalo, sheep, goat and camel meat with 9.03 kg/person as an annual red meat consumption per capita (Barakat et al., 2023). In the other hand, chicken meat is the most popular and produced meat source due to its low price in comparison with beef meat. In 2020, chicken meat production in Egypt is estimated around 1.5 million tons with poultry meat consumption per capita reached 14.3 kg. Chicken meat production is continuously increased, where it was 0.95 million tons in 2013 and 1.59 million tons in 2023 (*FAO*, 2023).

Growth promoters are substances added to feed or implanted in animals to increase meat and milk production. Hormones are one of the growth promoters which can improve the rate of meat production on animal and poultry farms. Estradiol, progesterone, testosterone, zeranol, trenbolone, and melengestrol are the most common anabolic hormones, which are used to increase nitrogen retention and protein deposition in livestock (Cawthorn et al., 2013).

Estradiol is present naturally in all mammals at different levels according to species, age, and sex. It is used as a growth promoter in animals to increase meat production yield by two to tenfold (Paris et al., 2006). Studies showed that the exogenous estradiol residues in meat are lower than the human daily produced hormone (European Food Safety Authority (EFSA), 2007; Joint FAO/WHO Expert Committee on Food Additives ([JECFA], 2006; Paris et al., 2006). Although inactivation of exogenous estradiol occurs through different metabolic processes and it has a low bioavailability, it is highly drainage in milk than in peripheral circulation so it causes DNA adducts and promotes cancer, especially breast cancer (Diamanti-Kandarakis et al., 2009; Malekinejad et al., 2006). According to the International Agency for Research on Cancer (IARC), estradiol-17β is classified as a Group I human carcinogen (IARC, 1987).

Progesterone is produced naturally in the ovaries and placenta and is considered one of the essential hormones in humans and animals for ovulation, maintenance of pregnancy, development of mammary glands, and neurobehavioral roles (Conneely et al., 2000; Zalanyi, 2001). It is used as a feed additive for animals to increase feed efficiency, promote weight gain, and play a role in estrus suppression in beef heifers (FDA, 2013). Although progesterone is not toxic at levels below those essential for hormonal effects, but it has a carcinogenic effect on its hormonal activity level (*FAO*/WHO, 2012; FDA, 2014). Also, residues of progesterone in edible tissues are considered safe and do not pose a risk to human health if below their safe levels production (FDA, 2014; Sers, 2013).

Testosterone is synthesized in testicular leydig cells, ovarian thecal cells, and the adrenal cortex. The major functions of testosterone are pubertal development for spermatogenesis, regulation of the differentiation of the prostate, stimulation of erythropoietin production in the kidney and stem cells of the hemopoietic system, and the acceleration of growth during puberty in conjunction with growth hormone. Prospective epidemiological studies showed a relationship between circulating levels of testosterone and breast cancer risk, especially among postmenopausal women (Missmer et al., 2004).

Although the natural presence of estradiol, progesterone, and testosterone in the human body and their role in physiological function regulation are known, concentrations of meat and meat products derived from livestock treated with the mentioned hormones can cause exposure of consumers to various levels of the residues, which act as a human health risk and lead to endocrine, infertility, arteriosclerosis, dysfunctional, immunological, neurobiological, immunotoxic, genotoxic, and carcinogenic toxic effects (Donovan, 2015). Many countries, such as Brazil, Turkey, Iran, and the European countries (Denmark, Germany, and Italy), restrict and ban the use of hormones in livestock breeding and forbid the import of meat obtained from countries that use hormonal growth promoters (Donovan, 2015; European Community (EC), 2010; Ferrao and Bressan, 2006).

The opinions among European countries and the United States towards hormonal usage is different. The European Economic Community (EEC) banned the use of all hormones and hormone-like substances as growth promoters; on the other hand, the United States Food and Drug Administration (USFDA) has permitted the limited use of some natural origin hormones in animal fattening (Herago and Agonafir, 2017; Nazli et al., 2005; Ronquillo and Hernandez, 2017).

The exposure and effect of hormone residues vary individually according to different factors, such as the consumer's eating habits, age, sex, and the concentration of hormone residues in meat and meat products (Anonymous, 2000). Acceptable daily intakes (ADIs) of estradiol, progesterone, and testosterone are 0–0.05, 0 to 30, and 0–2 μg/kg bw, respectively (JECFA, 2006, 2000, 1988; Jeong et al., 2010; Paris et al., 2006).

Finally, the use of growth-promoting substances must be ideal for producers, animals, and consumers, which means acceleration of animal growth in a short time with limited residues in its edible tissues and without any adverse effects on the biological functions and health of consumers. Anabolic substances that do not meet these three conditions must be strictly forbidden (Yücel et al., 2018).

The current survey aimed to detect and quantify some hormonal residues in chicken and cattle meat, and try to assess their present and future risks, either for adult or child consumers. Chicken and cattle meat were intended chosen for hormonal residues detection in the current study as they act a basic and popular component of the diet on most Egyptian tables due to their nutritive value and high production rates.

Section snippets

Sample collection, extraction, and analysis

A total of 92 samples of chicken meat from four different chicken sales outlets 23 samples per farm and 56 samples of beef from two brands 28 samples per brand were collected from Assiut City during July to December 2022. Around 100–150 g fat-free chicken and beef samples were collected, rapidly transferred to the laboratory in polyethylene bags, and stored at −20 °C until analysis. Chicken and beef samples were prepared and extracted according to Elbagory et al. (2017).

The detection of hormonal ...

Results

In the current study, the hormonal residue concentrations have been shown in mean, standard error, and minimum to maximum values.

In chicken meat samples, estradiol, progesterone, and testosterone residues mean (μg·kg-1) in four farms were 0.49 ± 0.02, 0.55 ± 0.005, 0.78 ± 0.009, and 0.79 ± 0.005 for estradiol, 0.45 ± 0.014, 0.52 ± 0.006, 1.31 ± 0.05, and 0.59 ± 0.009 for progesterone, and 0.73 ± 0.008, 0.74 ± 0.03, 0.87 ± 0.01, and 0.94 ± 0.006 for testosterone, respectively. Results showed ...

Discussion

Hormonal residues in meat and meat products are considered a threat to human health. National and international organizations have placed permissible limits on hormones to ensure human safety and facilitate world trade activity (Hirpessa et al., 2020), especially in countries that permit the use of most hormones for speeding up the growth of beef cattle, such as Spain, the United Kingdom, France, and the Netherlands (Bauer et al., 2000).

Chicken and beef meat samples in the current study were ...

Conclusion

As a result, this study concluded that anabolic hormones used as growth promoters on chicken and cattle farms and their residues exceeded the MRLs. EDI and HI play a key role in consumer food risk assessment. There are different shortcomings in the current study application in Egyptian field:

First, ELISA is considered just a screening test and must be followed with more sensitive, selective, and accurate analytical methods as chromatographic analytical methods for human health safety and ...

CRediT authorship contribution statement

Heba F. Kamaly: conception and design of samples collection and lab. work, analysis and interpretation of the data and drafted the manuscript; Ahmed A. Sharkawy: revised the manuscript and prepared the final version for journal. ...

Declaration of competing interest

The authors declare that there is no conflict of interest. ...

References (53)

D.-M. Cawthorn et al.
A high incidence of species substitution and mislabelling detected in meat products sold in South Africa
Food Control (2013)

S.V. Kumar et al.
Adverse effects on consumer's health caused by hormones administered in cattle
Int. Food Res. J. (2018)

P. Sons et al.
World meat consumption patterns: an overview of the last fifty years (1961–2011)
Meat Sci. (2015)

S. Zalanyi
Progesterone and ovulation
Eur. J. Obstet. Gynecol. Reprod. Biol. (2001)

Livestock Production Systems Spotlight, Cattle, Buffaloes, and Poultry Sectors in Egypt
(2017)

R. Akkoyu et al.
The research of pollution by anabolic hormones, beta-agonists and pesticides in meat and other organs of broilers in Turkey
The Journal of Etlik Veterinary Microbiology (2004)

Anonymous
Food Series 43, FAO Food and Nutrition 41/12
(2006)

B.A.A. Borokot et al.
Economic indicators of red meat production in Egypt
Egyptian Journal of Agricultural Economics (2023)

D.J.P. Barker
The developmental origins of adult disease
Eur. J. Epidemiol. (2004)

E.R.S. Bouer et al.
Characterisation of the affinity of different anabolics and synthetic hormones to the human androgen receptor, human sex hormone binding globulin and to the bovine progestin receptor
Agenic (2000)

Cited by (2)