

## Quantitative and qualitative assessment of additives present in broiler chicken feed and meat and their implications for human health

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### Abstract

**Objectives:** To determine the various constituents of commercial, broiler chicken feed and the presence of these constituents in their meat.

**Methods:** The experimental study was conducted at the Pakistan Council of Scientific and Industrial Research laboratory, Karachi. Samples of commercial broiler chicken feed and meat were collected in 2015 from a large poultry farm that supplies chicken meat to various suburban areas of the city. Another set of organic chickens were bred in an animal house. The samples of feed, meat and droppings were then analysed for the estimation of basic constituents and additives in the laboratory. Data was analysed using SPSS 20.0.

**Results:** The constituents were measured in 26 samples of chicken meat from each group. Calories ( $p < 0.01$ ), amount of protein ( $p < 0.01$ ), total fats ( $p < 0.05$ ), cholesterol ( $p < 0.01$ ), saturated fats ( $p < 0.01$ ), monounsaturated ( $p < 0.05$ ) and polyunsaturated fats ( $p < 0.01$ ) were significantly increased in commercial broiler chicken compared to that of organic chicken meat. The commercial chicken feed was found to contain crude carbohydrate, crude protein, crude fat, crude fibre, vitamins, amino acids, premixes of vitamins and toxicities of roxarsone, melamine and pesticides. Additive constituents were also present in the commercial chicken meat. These components were absent in organic chicken meat and droppings which suggests that they were absent in their feeding contents.

**Conclusion:** Organic chickens were found to be safer for consumption than commercial chickens.

**Keywords** Antibiotics, Chicken feed, Conventional caged chicken meat, Melamine, Organic chicken meat, Roxarsone, Steroids, Pakistan. (JPMA 68: 876; 2018)

### Introduction

Poultry is the most enjoyed food item these days. This is due to the superior taste, good quality and easy availability at cheap price compared to fish and red meat. Chickens are considered to be one of the best sources of proteins for the human body. The caloric content with fulfilling nutritional content makes it the best contender in the edible market. The exaggerated consumption of chicken has encouraged farmers and the business sector at large to breed and rear more chickens, aiding in the construction of new and well-equipped poultry farms. These farms use broilers for meat production and layers for solely egg production. It is documented that chickens generally take more than three months to grow to a size fit for human consumption.<sup>1</sup> At the end of three months they usually attain the weight of more than or equal to 1.5kg.<sup>2</sup> This duration is considerably long and needs to be

shortened to fulfil the chicken requirement of the masses.<sup>3</sup> For that reason specialised poultry feed is introduced in the market to enhance poultry growth in shorter time periods.<sup>4</sup> Poultry feeds are essentially of two types. The one for the broilers contains predominantly proteins and fats to ensure the growth and rapid weight-gain of the chickens. On the other hand, the layer hens are fed upon feeds that are rich in calcium content. This calcium-enriched feed helps maintain the calcium content constant in the body which is necessary for the development of eggs.<sup>5</sup>

The conventional broilers are fed on commercial feeds while the organic ones are fed on the natural grains and grit and are allowed to roam free. These organic chickens consume grains and water ad libitum and subsequently excursion on the vast ranges help digest and utilise energy from them in a healthy manner. For this reason the meat content and the nutritional values of both the chickens are extensively different from each other. Consequently a sequential cycle is designed by producing commercial feed, its provision to the broilers to enhance their weight-gain as well as growth and then consumption by the population. The current study was planned to evaluate the contents and the nutritional

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values of chicken feed, to compare commercial chicken meat with organic chicken meat, and then to assess their health benefits on humans.

## Materials and Method

The experimental study was conducted at the Pakistan Council of Scientific and Industrial Research (PCSIR) laboratory, Karachi. Samples of commercial broiler chicken feed and meat were collected in 2015. After approval was obtained from the ethical committee of Baqai Medical University (BMU), Karachi, the samples of broiler chicken feed and meat were collected from a large poultry farm that supplies chicken meat to the various suburban areas of the city. The recipe of broiler feed is similar in other parts of the country. Sample size was calculated using the method of mean difference on OpenEpi sample size calculator version 3.01. To achieve 95% confidence interval (CI), 80% power of study and 5% margin of error, the required sample size was 10 birds for each group.<sup>6</sup> Live commercial chickens were purchased from the said farm whereas organic chickens were bred at the BMU animal house. Live commercial chickens were immediately taken to BMU animal house where they were slaughtered and skinned. The organic chickens were bred in-house for three months and then slaughtered and skinned just like the commercial chickens. The organic chickens were fed on grains and grit and were allowed to wander freely on the grounds of the animal house. One pound of each sample including commercial chicken feed

for broiler chickens, conventional broiler chicken meat, and organic chicken meat as well as droppings of both conventional and organic chickens were sent to the PCSIR laboratory for estimation of the constituents in them.

Data for the constituents of commercial and organic chicken meat was analysed by independent sample t-test using SPSS 20.0.

## Results

The constituents were measured in 26 samples of chicken meat from each group. The constituents of broiler chicken feed sources and their observed concentrations were noted separately (Table-1). The broiler chicken feed, which is prepared commercially, contains cereals, vegetable oil, animal protein, calcium, mineral supplements, trace elements, sodium, amino acids, toxicities, and some additives like enzymes and antibiotics and miscellaneous constituents.

Major constituents present in broiler chicken and organic chicken meat were also noted (Figure). Calories ( $p < 0.01$ ), amount of protein ( $p < 0.01$ ), total fats ( $p < 0.05$ ), cholesterol ( $p < 0.01$ ), saturated fats ( $p < 0.01$ ), monounsaturated ( $p < 0.05$ ) and polyunsaturated fats ( $p < 0.01$ ) were significantly increased in commercial broiler chicken compared to that of organic chicken meat.

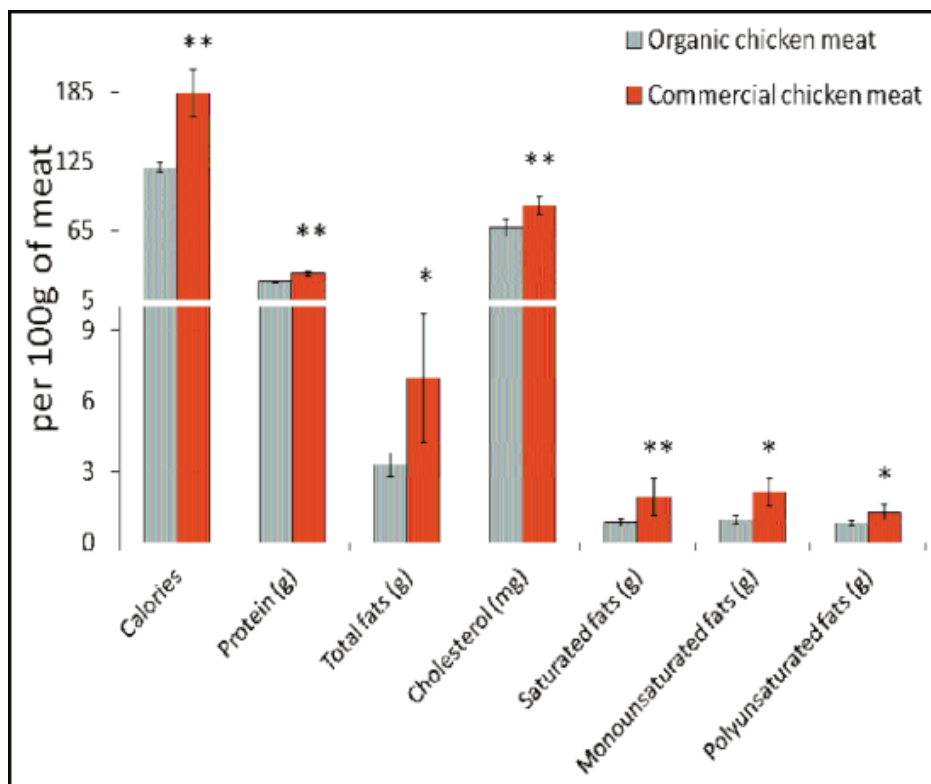
The samples of commercial chicken feed, commercial and organic chicken meat and their droppings were

**Table-1:** Amount of the constituents were measured in gram per 100 g of chicken feed.

Contents	Amount (g/100 g)
Coarsely ground grains (corn, wheat, barley, oats, rice, sorghum I and II etc.)	50
Wheat bran, milk feed, rice bran, milling by products	18
Soya bean meal, peanut meal, cotton seed meal, sunflower meal, canola meal, pea meal, safflower meal, sesame meal etc. (soya bean meal is predominant)	15
Meat meal, fish meal	5
Animal fat and crude fat	2
Crude fibre, tannasia, Yeast, milk powder	3
Vitamin premixes and vitamin supplements	+
Salt and trace minerals, amino acids	1
Bone, deflourinated dicalcium phosphate etc.	2
Ground lime stone, marble, oyster shells	2
Others (additives: antibiotics, pesticides, roxarsone, melamine)	2

**Table-2:** Shows the presence (+) and absence (-) of additives in feed, meat and droppings.

	Commercial chicken feed	Commercial chicken meat	Commercial chicken droppings	Organic chicken meat	Organic chicken droppings
Roxarsone	+	+	+	-	-
Melamine	+	+	+	-	-
Antibiotics	+	+	+	-	-
Steroids	+	+	+	-	-
Pesticides	+	+	+	-	-



\* $p < 0.05$ , \*\* $p < 0.01$ .

**Figure:** Constituents of commercial chicken meat and organic meat. Values are mean SD (n=26). Data was analysed by independent sample t-test.

also analysed for the presence of additives. Roxarsone, melamine, antibiotics, steroids and pesticides were observed in commercial chicken feed and commercial and organic chicken meat as well as in droppings (Table-2).

## Discussion

Poultry is considered to be one of the chief sources of protein for people of Pakistan.<sup>7</sup> Over the last few years poultry has become a prevailing and encouraging business sector in Pakistan.<sup>8</sup> It has enabled the people to grow revenues and to live better lives. The increase in demand of the chicken meat has led to the formation of more chicken farms and pens to hold more and more chickens for rearing purpose and to meet the demand for chicken supply. The raw materials for the construction of poultry feed are of numerous sources and origins. This chicken feed comprises all the basic ingredients holding basic nutritional needs for the chickens.<sup>3</sup> To speed up the growth certain ingredients are added to the feed that accelerate the growth and allow the chickens to develop to a certain size with weight more than 1.5 kg within 6

weeks.<sup>8</sup> In the present study the analysis of commercial broiler feed revealed that the added ingredients not only contain beneficial elements as vitamins, amino acids but also medicinal compounds as antibiotics, and noxious additives including roxarsone and steroids.<sup>9</sup> These ingredients themselves pose harmful effects not only to the chickens individually by concentrating in the flesh but also to the consuming population.

One of the notable findings in the commercial broiler feed was the presence of antibiotics.<sup>7</sup> The remnants of the antibiotics were also found in the commercial broiler chicken meat as well as in the droppings of chickens fed on this feed. The presence of antibiotics in organic chicken meat and droppings was not observed.<sup>8</sup> Antibiotics are considered to be an essential component of feed to provide beneficial protection to the poultry against bacterial infections.<sup>10-12</sup> However, the remains of the antibiotics in turn shift towards potential toxicity for both the birds and the consuming humans. This is especially vital if the residual amounts are present in excessively high concentrations. Such presence of antibiotics is documented to bring antibiotic resistance in humans as well as in the poultry.<sup>13</sup> This opens avenues for mutated and much advanced bacteria resistant to antibiotics that causes epidemics wiping off the entire poultry in the farms as well as causing health concerns for humans.

In the present study another interesting but potentially toxic element found in the commercial feed and meat and droppings was roxarsone. This was not found in organic chicken meat and droppings. Roxarsone is an organoarsenic compound that is widely used in poultry production as a feed additive to increase weight-gain and improve feed efficiency and as a coccidiostat which is a substance administered to poultry in order to impede the growth as well as reproduction of coccidian parasites.<sup>14</sup> A recent study showed the connection of the use of

roxarsone along with other arsenical feed additives to augmented levels of inorganic arsenic in chicken breast meat.<sup>14</sup> These arsenical compounds are added in the feed to provide nitrogen to the poultry as a mean of building proteins and muscle mass in them. Breast meat from conventionally produced chickens is found to have many fold increase in arsenic concentrates than rest of the body.<sup>15</sup>

Melamine, another ingredient of commercial chicken feed, was found to be present in commercial broiler chicken meat and droppings in the present study. Melamine was not observed in organic chicken meat and their droppings. Melamine is deceitfully added to chicken feed owing to its chemical composition and high levels of nitrogen atoms.<sup>15</sup> The risk of melamine contamination of certain raw materials intended for animal or poultry consumption has steered the health authorities to collect supplementary data on the likelihood of impending transfer of melamine to poultry. This may lead to its concentrates in the flesh of chickens and their products fated for human consumption, such as eggs and meats.<sup>16</sup> The study was therefore conducted in broiler hens to determine the presence of melamine in their flesh and droppings. This may enable to concentrate on the perspective of human and animal health. The research shows that melamine is a well-recognised nephrotoxic agent that may result in kidney damage and finally renal shut down.<sup>14</sup>

There are other components of feed that pose risk to the birds as well as to humans upon consumption. One of such constituent is pesticides. The pesticides are added in poultry feed and has been determined as a cause of serious concern for several years about its damaging effects.<sup>17</sup> The adulteration of the poultry products with pesticide residues concluded the presence of high levels of organochlorine pesticide in poultry feed.<sup>18</sup> The organochlorine pesticides, including  $\beta$ -hexachlorocyclohexane (HCH) and dichlorodiphenyltrichloroethane (DDT) with their existence in muscle and eggs at the farms showed that poultry feed concentrates of pesticides become the major sources of contamination for chicken tissue and eggs and these subsequently become harmful for human consumption.<sup>19</sup> Animals intended for human sustenance absorb pesticides from residues in their feed, water or during direct or indirect exposure in the course of pest control.<sup>20</sup>

On the other hand the organic chickens in the present study were grown on the organic diet comprises the grains and grit. The grains consist of maize, soybean<sup>21</sup> as well as corn and the grit composed of small rocks and sand that the hen pecked during feeding of grains. The grit helped the gizzard of the hens to churn and digest the

ingested grains. Besides feeding healthy grains, the organic hens were kept devoid of any antibiotics and additives. They were allowed to wander freely to the open ranges to help them utilise the energy from the grains. This exercise poses them healthy and renders them free of obesity.

The caloric content of the commercial chicken meat was significantly higher owing to increase in the carbohydrate content compared to that of the organic chicken meat.<sup>7,22</sup> Likewise, with the commercial chicken meat the protein content was significantly high compared to the organic chicken meat. The augmented protein content may be due to the presence of rich nitrogenous substances and amino acids in the feed of the commercial chicken diet that were absent in the organic chicken meat.<sup>23</sup> This is also acknowledged that certain nitrogenous components are added to enable commercial broilers to grow having high protein content are toxic and injurious to health.<sup>24</sup> These include roxarsone, arsenic and even pesticides and melamine in the diet.<sup>25</sup>

The total fats in the commercial broiler chickens incorporate all types of fats including saturated, monounsaturated and polyunsaturated fats as well as cholesterol. These fats were observed to be significantly raised in the commercial chicken skinless and boneless meat.<sup>26</sup> The total fats may be the reason of high caloric content of the commercial chicken meat. The health concerns of the increased fatty acids may also be considered while consuming commercial chicken meat. These concerns increase in the causation of the cardiovascular disorders (CVD) including atherosclerosis, plaque construction in blood vessels and raised blood pressure.<sup>27</sup> These conditions may ultimately lead to hypertension that may end up in the cerebrospinal accidents as stroke.<sup>1</sup> Likewise, the commercial chicken meat may also cause obesity due to high fatty acids and fat contents by providing high energy to the body.

Cholesterol is also supplied through commercial broiler feed and it is an important component of the plasma. It is the building block of cell membrane, and facilitates in the rejuvenation of the damaged cells. Moreover, the cholesterol links with the synthesis of the steroidal sex hormones, including androgens, progesterone and estradiol.<sup>28</sup> It is also the precursor of cortisol excreted by the adrenals in the body. Meta-analyses have found a considerable relationship between saturated fat and serum cholesterol levels. High total cholesterol levels, which may be caused by many factors, are associated with an increased risk of (CVD).<sup>29</sup> However, other indicators measuring cholesterol, such as high total to high density lipoprotein (HDL) cholesterol ratio, are more predictive of

CVD than total serum cholesterol. There are other pathways involving obesity, triglyceride levels, insulin sensitivity, endothelial function and thrombogenicity that also play major role in CVD although it appears that in the absence of an adverse blood lipid profile, the other known risk factors have only a weak atherogenic effect.<sup>29</sup> Different saturated fatty acids are known to have differing effects on various lipid levels in the body with varied associated health risks.

Furthermore, in the present study presence of steroids were also observed in commercial chicken feed, meat and droppings, whereas, organic chicken meat and droppings were free of these steroids. Steroid hormones are recognised as prevailing compounds that have wide biological effects in animals and humans. In both, estradiol, progesterone, and testosterone occur naturally and in identical molecular forms.<sup>30</sup> These steroids, when ingested by humans via meat consumption, would have the same biological activity in the human body as the hormones produced naturally by the organism.<sup>1</sup> Additionally, these natural or synthetic steroids have a very limited linkage or bonding to human plasma proteins, remaining free in the bloodstream and thereby increasing their potential effects. Any abnormality in their synthesis or imbalance of their concentration in the blood may lead to a range of disorders in the body. Although there are a few studies that compared raw versus cooked meat, stating that cooking does not affect majorly on the constituting elements, but there is formation of aromatic acids that add to the flavour and smell of the cooked food making it palliative.<sup>31</sup> However, upon extended length of cooking of the chicken meat for three or more than three hours, changes occur in the texture of the flesh as the water content gets effected and shortening of the muscle tendons take place. Yet no other major change occurs in the constituting components of the chicken meat.<sup>31</sup>

The strength of the study is showing the presence of harmful ingredients in the feed and their concentration in the flesh of the conventional chickens rendering that can be unsafe for human consumption. The limitation of the study is that the additive constituents were not measured quantitatively. Moreover, the area of the study is untapped and needs further investigations on constituents of feed in different regions of the subcontinent. Also, the implications of such type of feed on chickens with or without any remnants in the flesh of the consuming birds was also not explored. Furthermore, different breeds of hens are marketed and are the market preferences in our neighbouring countries is also a factor as few of the breeds are also interestingly taken into consideration of the local Indians, one of such breed is

"Aseel" chicken breed.<sup>32</sup> The net effects of such feed may also be taken into consideration in all the breeds of interest as the genetics may vary and then the effect of such fortified feed on these birds and their consuming population may enable us to translate such effects in humans with net effects on their health. This may essentially add both male and female subjects, not only adults but also children who nowadays consume chicken products more or less on a daily basis.

## Conclusion

Certain non-nutritional additives were found as toxicities in the feed fed to commercial chicken that can be hypothesised to concentrate in their chicken flesh and may exert deleterious effects on the health of human consumers. It is imperative to remove these additives in commercial feed and promote organic chicken consumption that are bred on whole grains without any supplementation of additives. More studies are required in this field as well as in vivo experiments to examine the injurious effects of broiler chicken on human health.

**Acknowledgment:** We are grateful to BMU for providing research facilities.

**Disclaimer:** None.

**Conflict of Interest:** None.

**Source of Funding:** None.

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