IRRADIATION DECONTAMINATED POULTRY FEED IN DIFFERENT PACKAGING MATERIALS

*ZULQARNAIN¹, AURANG ZEB², HAMID ULLAH SHAH¹, ZAFAR IQBAL¹ and FAZAL MAHMOOD²

¹ Agricultural Chemistry, The University of Agriculture, Peshawar - Pakistan.
² Nuclear Institute for Food and Agriculture (NIFA) Peshawar - Pakistan.
*Corresponding author: nainagch@gmail.com

ABSTRACT

Irradiation an alternative to antibiotics is an interesting area of poultry feed research and has been recognized as a reliable and safe method for preservation. Present study was conducted to investigate the influence of gamma irradiation (5kGy) and storage at ambient conditions on proximate analysis of antibiotic free broiler feed packed in different packaging materials. Results indicated that moisture content of the experimental feed samples was influenced (P ≤ 0.05) by all the three factors. It increased with storage time, more so in irradiated samples than in their respective controls. Protein solubility was also influenced (P ≤ 0.05) by all the three factors and their interactions. The average phytic acid contents of all the samples ranged between 1.04 to 2.10 %.

Keywords: Irradiation decontamination; Poultry feed; Packaging materials


INTRODUCTION

Poultry feeds are referred to as complete diets because they contain a mixture of stuffs including cereal grains, soybean meal, fish meal, bone meal, animal byproducts which together with water provide all the vitamins, minerals, protein and energy for the proper growth of poultry (NRC, 1994). Corn and Soybean meal are extensively in use for the poultry feed due to their low cost, high source of energy and protein while fish and meat meals are good sources of amino acids (Chiba, 2009). Soybean meal is the most important protein source for poultry to which all other protein sources are compared. It contains high level of protein and high profile of amino acids, and is thus considered as the “gold standard” among the protein sources (Cromwell, 1999).

Dietary protein plays an important role on the overall growth performance of the poultry. The balanced amount of protein is essential in feed. Protein supplements are very expensive thus its optimal use is very important to avoid wasteful usage and reduce the cost of production (Wolde et al., 2011). The excess dietary protein could possibly be reduced from the diet if there are sufficient amount of amino acids needed for the growth (Firman and Boling, 1998). The diet containing the protein fortified with methionine and lysine perform very well than the diets higher in proteins (Jensen and Colnago, 1991).

The use of antibiotics in feed has got many benefits. Antibiotics are added to the feeds to treat and prevent infections and thus improve the growth of poultry (Barton, 2000). The first step towards re-evaluating the role of antibiotics as growth promoters was made by the Swann Committee in 1969 (Swann Committee, 1969). This Committee initiated restrictions on the use of AGPs. Besides its beneficial use, scientists are now relating the sub-therapeutic use of antibiotics to the spread of antibiotic resistant bacteria in human population (Goforth and Goforth, 2000).

Alternative to antibiotics as decontamination source is an interesting area of poultry feed research. Irradiation, a new technology enhances food safety, quality and trade. It is the process in which food is exposed to gamma rays from a radioactive source such as Cobalt-60. These gamma rays penetrate the feed and its packaging and thus kill the microbes and harmful parasites (Caulfield et al., 2008). It is referred to as “cold pasteurization” process as it does not increase the temperature of the treated foods / feeds (Loaharan, 2003). The utilization and digestibility of proteins and carbohydrates is improved with the use of radiation by converting them into easily digestible forms. (Nene et al., 1975).

Present study was conducted to investigate the influence of gamma irradiation (5kGy) and storage at ambient conditions on proximate analysis of antibiotic free broiler feed packed in different packaging materials.

MATERIALS AND METHODS

The antibiotic free poultry feed samples were prepared and collected from Sadiq Brothers (SB) Poultry Feed Mill, Mandra, Rawalpindi, Pakistan. The collected samples were packed in three different packaging materials. The packaging materials were:
1. Polypropylene woven bags (PP),
2. Polypropylene woven (PP)+Polyethylene bags (PE),
3. Cardboard cartons (CB) + Polyethylene bags (PE).

The above three packaging variants after filling and coding were gamma irradiated at a dose of 5 kGy.

Moisture content and protein contents were determined using the standard methods of AOAC (2000) while protein solubility and phytic acid contents were determined by the methods described by Araba and Dale (1990) for protein solubility and Haug and Lantzsch (1983) method for phytic acid contents.

Statistical Analysis

All the data were statistically analyzed for Analysis Of Variance (ANOVA) according to Steel and Torrie (1980) using Completely Randomized Design (CRD) with 2 x 3 x 4 factorial arrangement. Means were separated using Least Significant Difference (LSD).

RESULTS AND DISCUSSION

Data on various parameters of control and irradiated samples packed in different packaging materials are given in Tables 1 to 3.

Moisture

Moisture content of the experimental feed samples was influenced (P ≤ 0.05) by all the three factors, namely treatment, packaging and storage. It increased with storage time, more so in irradiated samples than in their respective controls (Table 1). In control samples a significant increase was recorded only during the third month, while in irradiated samples a regular increase was noted at all the storage intervals. Also the maximum average level (9.05%) attained in case of irradiated samples was higher than the corresponding value (8.50%) in control samples. There was no statistically significant difference in the moisture content of un-irradiated control samples packed in packaging materials PP+PE and C+PE, while the PP packaging showed significant difference than the other two packaging materials.

Table 1. Effect of gamma irradiation (5 kGy) and storage on the moisture content (%) of differently packed poultry feed

<table>
<thead>
<tr>
<th>Storage Days</th>
<th>Control Samples</th>
<th>Irradiated Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PP+PE</td>
<td>PP</td>
</tr>
<tr>
<td>0</td>
<td>7.46</td>
<td>7.21</td>
</tr>
<tr>
<td>30</td>
<td>7.77</td>
<td>7.36</td>
</tr>
<tr>
<td>60</td>
<td>7.80</td>
<td>7.59</td>
</tr>
<tr>
<td>90</td>
<td>8.90</td>
<td>8.09</td>
</tr>
<tr>
<td>Mean</td>
<td>7.98 B</td>
<td>7.56 C</td>
</tr>
</tbody>
</table>

PP+PE = Polypropylene woven + Polyethylene (2 layered) bags, PP = Polypropylene woven bags, C+PE = Cardboard carton + Polyethylene, LSD Value for Packaging: 0.29 and for storage: 0.33

Among the control the highest average moisture content (7.98%) was found for twin packing (PP+PE) followed by C+PE (7.86%) and PP (7.56%), whereas among the irradiated lot, the samples packed in all the three packaging materials were found non-significantly different from each other. The average moisture content was found highest (8.47%) for the packing (PP and C+PE) while the twin packing resulted in the lowest (8.31%) moisture content.

Moisture content of feed is an important factor in relation to its storage life. Moisture contents and the possibility of moisture uptake determine to a large extent the microbial growth on it. Irradiation decontamination become meaningless if the feed is allowed to absorb moisture from the environment. During the present experiment the moisture content of feed packed in PP+PE remained almost unchanged during the entire storage time of 3 months at the farmer’s shed conditions.

Influence of irradiation on moisture contents of pelleted poultry feed has not yet been reported but there are some reports indicating that gamma irradiation of whole-corn grains was effective in preventing moldiness of low moisture corn grains for about 60 days (Paster et al., 1991). Azzeh et al. (2011) reported that irradiation upto 10 kGy did not influence ash, protein, water content of semolina and wheat grains.

Protein Solubility

Protein digestibility is an important factor in determining the quality of protein because there may be certain amino acids present in the food but may not be available to the organism which means that protein cannot be
utilized unless and until it is digested. Protein solubility in 0.5M KOH in all the samples was measured as an indicator of its digestibility (Table 2). This parameter was influenced ($P \leq 0.05$) by all the three factors and their interactions.

The protein solubility of the control and the irradiated samples packed in PP+PE and C+PE were found to be non-significantly different from each other while the packing (PP) showed a significant difference from the other two packaging materials. Twin packing (PP+PE) of the irradiated as well as the control samples gave the highest value (15.74%) and (15.54%) respectively. The highest value for protein solubility in the twin packing of irradiated sample showed a significant effect of both the irradiation and packaging material in controlling the protein solubility. During the 3 months of storage, protein solubility was found within a narrow range of 13.69-16.62%.

<table>
<thead>
<tr>
<th>Storage Days</th>
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<th>Irradiated Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PP+PE PP C+PE Mean</td>
<td>PP+PE PP C+PE Mean</td>
</tr>
<tr>
<td>0</td>
<td>14.94 15.53 16.97 15.82 C</td>
<td>17.12 15.34 17.41 16.62 B</td>
</tr>
<tr>
<td>30</td>
<td>16.44 14.18 11.01 13.87 EF</td>
<td>13.81 14.90 15.77 14.83 D</td>
</tr>
<tr>
<td>60</td>
<td>18.65 14.68 18.96 17.43 A</td>
<td>17.47 16.36 15.59 16.47 B</td>
</tr>
<tr>
<td>90</td>
<td>12.11 15.23 15.13 14.16 E</td>
<td>14.56 13.42 13.09 13.69 F</td>
</tr>
<tr>
<td>Mean</td>
<td>15.54 A 14.90 B 15.52 A</td>
<td>15.74 A 15.00 B 15.47 A</td>
</tr>
</tbody>
</table>

PP+PE = Polypropylene woven + Polyethylene (2 layered) bags, PP = Polypropylene woven bags, C+PE = Cardboard carton + Polyethylene, LSD Value for Packaging: 0.32 and for storage: 0.37

Current findings of the biochemical investigations on control and irradiated feed samples are not surprising. Improvement in the nutritional quality of feed in studies on various animal species has been reported quite frequently. Feeding studies on mini pigs (Lee et al., 2011) have shown higher ($P < 0.05$) protein digestibilities of the irradiated diets than autoclaved diets.

Irradiation treatment applied to food products cause irreversible change at molecular level of proteins conformation. These chemical changes include fragmentation, cross-linking and aggregation generated in the radiolysis of water by oxygen radicals. Therefore, changes of physiochemical properties are due to modification by the oxygen radicals in the structure of protein (Song et al., 2002).

Phytic Acid

The average phytic acid contents of all the samples ranged between 1.04 to 2.10 % (Table 3). However, within this narrow range the influence of irradiation treatment and storage as well as their interaction was highly significant ($P \leq 0.01$). The values for control samples, averaged across packing materials were 1.50, 1.36, 1.29 and 1.21% at 0, 30, 60 and 90 days storage respectively while the respective values for irradiated samples were 1.77, 1.48, 1.11 and 1.47%.

<table>
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<th>Control Samples</th>
<th>Irradiated Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PP+PE PP C+PE Mean</td>
<td>PP+PE PP C+PE Mean</td>
</tr>
<tr>
<td>0</td>
<td>1.81 1.55 1.13 1.50 B</td>
<td>1.81 2.10 1.41 1.77 A</td>
</tr>
<tr>
<td>30</td>
<td>1.47 1.15 1.46 1.36 D</td>
<td>1.72 1.46 1.25 1.48 BC</td>
</tr>
<tr>
<td>60</td>
<td>1.23 1.28 1.35 1.29 E</td>
<td>1.06 1.21 1.04 1.11 G</td>
</tr>
<tr>
<td>90</td>
<td>1.08 1.17 1.38 1.21 F</td>
<td>1.81 1.06 1.53 1.47 C</td>
</tr>
<tr>
<td>Mean</td>
<td>1.40 C 1.29 E 1.33 D</td>
<td>1.60 A 1.46 B 1.31 DE</td>
</tr>
</tbody>
</table>

PP+PE = Polypropylene woven + Polyethylene (2 layered) bags, PP = Polypropylene woven bags, C+PE = Cardboard carton + Polyethylene, LSD Value for Packaging: 0.02 and for storage: 0.03

9 to 43% reduction in the phytic acid content of rapeseed meal due to different heat treatments like toasting and autoclaving, while isolation of protein from that product eliminated 74 to 92% of phytic acid (Mansour et al., 1983). Studies on legumes, cereals and oilseeds showed that phytic acid is generally stable under ordinary processing conditions (Thompson, 1990). Microwave heating of soybean caused a 23% phytic acid reduction after 9 minutes and 46% after 15 minutes, while gamma irradiation (1kGy dose) reduced the phytic acid content of soybean by only 4% (Hafiz et al., 1989).

Cereals, oil seeds and food legumes contain phytic acid content within a range of 0.6-5% (Rackis and Anderson, 1977). There are number of studies available that showed that phytic acid form complexes with di and trivalent cations and proteins and is responsible for reducing the mineral bioavailability (Smith and Rackis, 1956).
CONCLUSIONS AND RECOMMENDATIONS

From the current study it was concluded that the in-vogue single layered Polypropylene woven bags, owing to their porosity allowed the feed to absorb moisture from the environment. The Cardboard carton + Polyethylene option, although seemed to be a sound idea, could not sustain the mechanical handling during filling, uploading, irradiation, transportation and storage. On the basis of these conclusions, following recommendations can be made; Poultry feeds should be irradiated at 5 kGy and packed in a twin layer packing (Polypropylene + Polyethylene) in order to get maximum benefits from it. Further research work should be conducted to determine the influence of the radiation decontamination of poultry feed on the physiology and biochemistry of the consuming poultry birds in order to establish the wholesomeness of the irradiated feed on one hand and to explore the nutritional benefits of the treatment on the other hand.

![Fig. 1](image1.png)
**Fig. 1.** Moisture content (%) of the control samples packed in three packaging materials during storage for 3 months.

![Fig. 2](image2.png)
**Fig. 2.** Moisture content (%) of the irradiated samples packed in three packaging during storage for 3 months.

![Fig. 3](image3.png)
**Fig. 3.** Protein solubility (%) of the control samples packed in three packaging materials during storage for 3 months.
Fig. 4. Protein solubility (%) of the irradiated samples packed in three packaging during storage for 3 months

Fig. 5. Phytic acid (%) of the control samples packed in three packaging materials during storage for 3 months

Fig. 6. Phytic acid (%) of the irradiated samples packed in three packaging materials during storage for 3 months

REFERENCES


