INNSPUB

International Journal of Biosciences | IJB |
ISSN: 2220-6655 (Print) 2222-5234 (Online)
http://www.innspub.net
Vol. 11, No. 1, p. 176-181, 2017

RESEARCH PAPER OPEN ACCESS

Effect of irradiation and packaging on the biochemical and microbiological characteristics of antibiotic free poultry feeds

Aurang Zeb[1], Zulqarnain[*2], Hamid Ullah Shah[2], Zafar Iqbal[2], Fazal Mahmood[1], Nazish Manzoor[2]

[1]*Nuclear Institute for Food and Agriculture (NIFA), Peshawar, Pakistan*

[2]*Department of Agricultural Chemistry, The University of Agriculture, Peshawar, Khyber Pakhtunkhwa, Pakistan*

Key words: Poultry feed, Irradiation decontamination, Feed packaging, Feed Antibiotics, Storage behavior

http://dx.doi.org/10.12692/ijb/11.1.176-181 Article published on July 21, 2017

Abstract

Alternative to antibiotics, irradiation is an interesting area of poultry feed research. Present study was conducted to find out the effect of gamma irradiation on the biochemical and microbiological parameters of antibiotic free broiler feed packed in 2 layered bags (PP+PE) in comparison to the local bags (PP) used for the packing of poultry feed. Results indicated that solubility of iron increased as a result of irradiation and 2 layered packaging while solubility of P was much higher than that of Fe. Sodium solubility increased in both the packaging. Among the irradiated samples the highest value of Potassium solubility was recorded in the 2 layered packing. Irradiation reduced the bacterial as well as the fungal load of the samples in both the packing materials while none of the factors brought significant changes in peroxide value of oil.

* **Corresponding Author:** Zulqarnain ✉ nainagch@gmail.com

Introduction

Poultry feeds are subjected to contamination through various sources including environment, insects and microbes (Van Barneveld, 1999). Diversity of different microbes in feeds is totally dependent on the moisture content, pH and nutrient composition of the feed. Although some microbes are not dependent on moisture for growth, generally for microbial survival, sufficient water is necessary and microbes survive unless and until sufficient water is present for their activity (Maciorowski *et al*., 2007).

Antibiotics are used both as therapeutic and growth promoting agents. Growth promoting use of antibiotics is in the form of low dose added to the feeds (Falcao *et al*., 2007). Antibiotic growth promoters selectively modify the gut flora, suppress bacterial catabolism, reduce bacterial fermentation and reduce the intestinal wall thickness. All these changes lead to increased health, increased nutrient availability for the animal and subsequently increased growth performance (Carlson & Fangman, 2000). Antibiotics are added to the feeds to treat and prevent infections and thus improve the growth of poultry (Barton, 2000). 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).

Gamma rays are the short length waves produced by the radioactive isotopes such as Cobalt 60. These gamma rays lower than 10 kGy are considered low and aimed at reducing the microbial population particularly for poultry products (Mantilla *et al*., 2012).

Present study was conducted to find out the effect of gamma irradiation on the biochemical and microbiological parameters of antibiotic free broiler feed packed in two packaging materials.

Materials and methods

The antibiotic free poultry feed samples were packed in two packing materials including the 2 layered packing Polypropylene (PP) with Polyethylene bags (PE) and the local bags (PP) that were used in the industry for packing of the poultry feed. Once packed, the samples were gamma irradiated at 5kGy and were analyzed for biochemical and microbiological parameters at 0, 30, 60 and 90 days.

Iron content was determined using the Spectrophotometric method 40-41 B (A.A.C.C., 1999). Phosphorus was determined calorimetrically using the Vanadate Molybdate method (Egan *et al*., 1981). Flame photometry was used for the determination of Na and K using the wet digestion method (Dell *et al*., 1972). The minerals in the samples were extracted using the same method as described by Duhan (Duhan *et al*., 2002). Peroxide value was determined using the method described by A.O.A.C. (2000) while microbiological analysis was carried out using dilution plate count method (IAEA, 1970).

Statistical analysis

All the data were statistically analyzed for ANOVA (Steel and Torrie, 1980). Means were separated using Least Significant Difference (LSD).

Results and discussion

HCl extractable minerals

Solubility of iron from feed samples was significantly ($P \leq 0.05$) influenced by all the three experimental factors and their interactions. It can be noted from the data (Table 1) that the value increased as a result of irradiation treatment. There was also an increase in Fe solubility during the storage, more so in irradiated samples than in control samples. As far the influence of packing materials, the highest average value (38.04%) for the Fe solubility among control samples was noted in local bags while among the irradiated the highest value (35.03%) was noted in 2 layered packing.

Solubility of P was much higher than that of Fe (Table 2). As in the case of Fe solubility, the P solubility was also influenced by all the three factors and their interactions. However behavior of P solubility was different in control and treated samples. In the control samples, the average values for 2 layered packing and local bags were found non-significantly different from each other.

In case of irradiated samples, maximum (55.96%) P solubility was found in packaging (PP+PE) while packaging (PP) showed minimum (41.06%) P solubility. Solubility of sodium was influenced ($P \leq 0.01$) by the irradiation which resulted an increase in its value in all the two packagings.

It was also influenced by the storage ($P \leq 0.01$); whereas the factor packaging had no significant effect. Na solubility was significantly reduced during a storage period of three months in both the irradiated and control samples. Among the packing materials of the irradiated samples, the values of Na solubility for PP+PE twin packing and PP were found non-significantly different from each other.

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

Storage Days	Control Samples		Irradiated Samples	
	PP+PE	PP	PP+PE	PP
0	12.03	10.62	9.41	16.69
30	55.59	81.42	53.59	29.33
60	37.39	27.10	53.88	56.71
90	19.51	33.03	23.25	15.82
Mean*	31.13 BCD	38.04 AB	35.03 BC	29.64 CD

*LSD Value for Packaging: 7.54

Table 2. Effect of gamma irradiation (5kGy) and storage on the P solubility (%) of differently packed poultry feed.

Storage Days	Control Samples		Irradiated Samples	
	PP+PE	PP	PP+PE	PP
0	46.71	50.68	80.36	58.05
30	89.47	90.76	47.12	32.66
60	87.81	70.80	44.22	58.37
90	20.20	32.39	52.12	15.16
Mean*	61.05 A	61.15 A	55.96 AB	41.06 C

*LSD Value for Packaging: 9.95

Potassium solubility from feed samples was influenced ($P \leq 0.05$) by the two factors irradiation and storage while the third factor packing had no significant effect. Irradiation treatment resulted in an enhanced value on the average, while during the storage the solubility of potassium decreased with each successive storage interval (Table 4). Among the control samples the highest average K solubility was noted in PP while among the irradiated ones the highest value was recorded with PP+PE packing. Divalent cations are associated with phytic acid, thus a decrease in phytic acid content can result in increased minerals extractability (Saharan *et al.*, 2001). HCl extractable minerals were significantly ($P \leq 0.05$) affected by the processing and cooking (Duhan *et al.*, 2002).

Table 3. Effect of gamma irradiation (5kGy) and storage on the Na solubility (%) of differently packed poultry feed.

Storage Days	Control Samples		Irradiated Samples	
	PP+PE	PP	PP+PE	PP
0	91.74	95.74	98.00	98.61
30	43.35	34.50	49.27	52.75
60	37.53	39.17	40.09	40.34
90	30.70	22.10	35.22	32.38
Mean*	50.83 BC	47.88 C	55.65 A	56.02 A

*LSD Value for Packaging: 3.38

Table 4. Effect of gamma irradiation (5 kGy) and storage on the K solubility (%) of differently packed poultry feed.

Storage Days	Control Samples		Irradiated Samples	
	PP+PE	PP	PP+PE	PP
0	87.89	96.26	92.67	97.46
30	68.05	89.26	65.40	62.75
60	62.75	66.28	58.33	56.56
90	58.33	59.21	83.07	53.91
Mean[1]	69.25 BC	77.75 A	74.87 A	67.67 C

[1]LSD Value for Packaging: 3.14

Peroxide value (meq/kg)

The peroxide value of oil extracted from the samples at each interval was determined to study the influence of the experimental factors. Results (Table 5) revealed that none of the factors brought in some significant changes in this parameter. However an important observation in this regard is the very high POV figures even at the initial analysis. Oil with POV above 10 is considered as rancid and is not rated as fit for human consumption.

However the very low concentration of oil in the feed may render the overall peroxides concentration in the feed very low. Effects of all the three factors were statistically non-significant ($P \geq 0.05$) on the peroxide value of the fat extracted from the experimental feed samples. Numerically, however both irradiation and storage resulted in increased POV. The gamma irradiation with storage significantly reduced the acid value while the peroxide value was increased as the dose increased (Osman *et al.*, 2012).

Table 5. Effect of gamma irradiation (5kGy) and storage on the POV (meq/kg) of differently packed poultry feed.

Storage Days	Control Samples		Irradiated Samples	
	PP+PE	PP	PP+PE	PP
0	17.62	17.56	17.42	14.25
30	15.85	14.57	18.06	16.30
60	13.77	15.43	15.90	13.72
90	16.20	17.40	17.30	16.60
Mean[1]	15.86 A	16.24 A	17.17 A	15.22 A

[1]LSD Value for Packaging: 2.38

Microbial load

All the three factors and their interactions had significant ($P \leq 0.01$) effects on bacterial load of the feed (Table 6). Irradiation reduced the bacterial load of the samples in both the two packing materials.

In case of irradiated samples the value remained statistically constant during the storage, whereas in control samples a reduction was noted in all the packing during the first month and then remained constant for the rest of the storage intervals.

The average bacterial load ranged from 3 to 5 log cycles in un-irradiated control samples. While in irradiated samples the averages counts remained within 2 log cycle among all the two packing domains. It is important to note that in all the samples the bacterial load remained within safe limits (≤ log cycles).

The mean TBC/g of the irradiated samples of both the two packing materials was found non-significantly different from each other but the twin packing (PP+PE) proved best in controlling the samples from being contaminated by the bacterial count.

The fungal counts (Table 6) of all the control as well as irradiated samples were 0 in the beginning, indicating a very high microbial safety at the mill and during the subsequent stages of transportation, irradiation and back transportation to the site of storage. However the counts increased in all the samples during storage ($P \leq 0.05$) but in none of the samples the count exceeded the safety limits of 5 cycles. Among the three packing materials twin packing (PP+PE) controlled the samples within a range of 7.50 E+00 and thus proved best in controlling the total fungal count.

The advantages of gamma irradiation relative to others methods is that it can be actively used to destroy bacteria and fungi due to its deep penetration (Baptista *et al.*, 2014).

The study indicated that the 2kGy improved the bacteriological quality of the raw whole milk and did not negatively affect the sensory characteristics (Silva *et al.*, 2015). 4 kGy radiation was sufficient to control the microbiological level and the best microbiological results may achieved by using 6 kGy (Al-Bachir and Othman, 2013).

Table 6. Effect of gamma irradiation (5 kGy) and storage on the TBC/g and TFC/g of differently packed poultry feed.

Storage Days	Control Samples				Irradiated Samples			
	PP+PE		PP		PP+PE		PP	
	TBC/g	TFC/g	TBC/g	TFC/g	TBC/g	TFC/g	TBC/g	TFC/g
0	3.60E+03	0.00E+00	6.50E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
30	2.15E+02	0.00E+00	3.65E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
60	2.75E+02	1.35E+03	4.00E+01	3.75E+02	2.50E+01	0.00E+00	3.75E+02	0.00E+00
90	2.90E+02	1.90E+02	5.50E+01	8.00E+01	6.50E+01	3.00E+01	2.61E+02	6.00E+01
Mean*	1.10E+03 C	3.85E+02	1.64E+04	1.14E+02 B	2.25E+01 A	7.50E+00	1.59E+02 A	1.50E+01 A

*LSD Value for Packaging: 1.50E+03

Conclusions

The two layered packing included polypropylene and polyethylene proved to be the best packing in order to reduce the microbial load of the antibiotic free poultry feed samples. It was also concluded that the minerals solubility increased by using different packing and irradiation. Further work may be needed to study the exact mechanism for the increase of minerals extractability or solubility.

References

AACC. 1999. Approved methods of the American Association of cereal Chemists. St. Paul Minnesota USA.

Al-Bachir M, Othman T. 2013. Use of irradiation to control microorganisms and extend the refrigerated market life of chicken sausage. Innovative Romanian Food Biotechnology **13,** 63-70.

AOAC. 2000. Association of official analytical chemists, Official methods of analysis. 17th Ed., Maryland USA.

Baptista RF, Lemos M, Vital HC, Carneiro CE, Marsio ET, Conte Jr CA, Mano SB. 2014. Microbiological quality and biogenic amines in ready-to-eat grilled chicken fillets under vacuum packing, freezing, and high-dose irradiation. Poultry Science **93,** 1571-1577.

Barton MD. 2000. Antibiotic use in animal feed and its impact on human health. Nutrition Research Reviews **13,** 279-299.

Carlson MS, Fangman TJ. 2000. Swine antibiotics and feed additives: food safety considerations. In: MU Guide, Agriculture, *G2353*, University of Missouri Extension Columbia.

Dell BL, Debol and AR, Yohann SRK. 1972. Distribution of phytase and nutritionally important elements among the morphological components of cereal grains. Journal of Agricultural & Food Chemistry **20,** 718-722.

Duhan A, Khetarpaul N, Bishnoi S. 2002. Changes in phytates and HCl extractability of calcium, phosphorus, and iron of soaked, dehulled, cooked, and sprouted pigeon pea cultivar (UPAS-120). Plant Foods for Human Nutrition **57,** 275-284.

Duhan A, Khetarpaul N, Bishnoi S. 2002. Content of phytic acid and HCl-extractability of calcium, phosphorus and iron as affected by various domestic processing and cooking methods. Food Chemistry **78,** 9-14.

Falcao CL, Castro SL, Maertens L, Marounek M, Pinheiro V, Freire J, Mourao JL. 2007. Alternatives to antibiotic growth promoters in rabbit feeding: A review. World Rabbit Science **15,** 127-140.

Goforth RL, Goforth CR. 2000. Appropriate regulation of antibiotics in livestock feed. Boston College Environmental Affairs Law Review 28, 39-78.

IAEA. 1970. Microbiological specification and testing methods for irradiated foods. Tech. Report series No. 104. IEAE Vienna.

Maciorowski KG, Herrera P, Jones FT, Pillai SD, Ricke SC. 2007. Effects on poultry and livestock of feed contamination with bacteria and fungi. Animal Feed Science & Technology **133,** 109-136.

Mantilla SPS, Santos EB, Freitas MQ, Vital HC, Mano SB, Franc RM. 2012. Refrigerated poultry breast fillets packed in modified atmosphere and irradiated: Bacteriological evaluation, shelf life and sensory acceptance. Brazilian Journal of Microbiology **43,** 1385-1393.

Osman GAM, Diab EE, Mahmoud NS, Elagib RAA, Rushdi MAH, Hassan AB. 2012. Effect of gamma irradiation and storage on fungal growth, aflatoxin production and quality characteristics of groundnuts. Tropentag 2012, Gottingen Germany.

Saharan K, Khetarpaul N, Bishnoi S. 2001. HCl extractability of minerals from rice bean and faba bean: influence of domestic processing methods. Innovative Food Science and Emerging Technologies **2,** 323-325.

Silva ACDO, Oliveira LAT, Jesus EFO, Cortez MAS, Alves CCC, Monteiro MLG, Junior CAC. 2015. Effect of gamma irradiation on the bacteriological and sensory analysis of raw whole milk under refrigeration. Journal of Food Processing and Preservation.
DOI: 10.1111/jfpp.12490.

Steel RGD, Torrie JH. 1980. Principles and procedures of statistics. New York Mc Graw.

Van Berneveld RJ. 1999. Physical and chemical contaminants in grains used in livestock feed. Australian Journal of Agricultural Research **50,** 807-823.