Research Article

Enrichment of Flaxseed for Developing Functional Rabbit Meat

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Abstract | Meat from rabbits is mostly recommended by dietitians because of its low calories compared to other traditional meat. The current study was carried out to investigate the dietary responses of flaxseed on the meat of rabbits. Rabbits were divided into three groups: T_0 rabbits were considered control group while T_1 rabbits were reared on 7% flaxseed, and T_2 were on 3.5% flaxseed in the feed of rabbits. Bearing in mind that this range of flaxseed will fulfil omega 3 Poly unsaturated fatty acid (PUFA) concentration that contributes 8.5% of the total fatty acids. Rabbits were reared for the period of eight weeks. Enrichment of 7% flaxseed in the diet of rabbits significantly enhanced growth performance of rabbits and improved poly unsaturated fatty acids in the meat of rabbits as compared to other groups.

Editor | Tahir Sarwar, The University of Agriculture, Peshawar, Pakistan.
Received |December 15, 2014; **Accepted** | March 18, 2015; **Published** | March 30, 2015
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Citation | Tariq, M. R., M. I. Khan, A. Sameen and M. Nisa. 2015. Enrichment of flaxseed for developing functional rabbit meat. *Sarhad Journal of Agriculture,* 31(1): 70-74.
Keywords | Rabbit, Flaxseed, n-3 PUFA, α-linolenic acid, Functional meat

Introduction

Functional foods are defined either to enhance physical roles in humans' bodies or to retard developing particular diseases. In both cases, it should be a food, and this must exhibit its impact within the food (Diplock et al., 1999). The nutritional value of rabbit meat comes with a significance of the factors that identify customer acceptability. Certainly, meat is really a major supply of proteins as well as essential amino acids. It is a good source of mineral, B vitamins and biologically active substances. Though, meat can be a chief supply of cholesterol and saturated essential fatty acids and its consumption might be associated with CVDs illnesses, diabetes, hypertension and overweight (Valsta et al., 2005). China (700, 000 ton/year) and France (51, 400 ton/year) are two major rabbit meat producing countries (FAOSTAT, 2010). Flaxseed feeding is a good option in diets of livestock to enhance the n-3 fatty acid concentration (Soita et al., 2003; Kronberg et al., 2006; Maddock et al., 2006). Even though rabbit meat provides outstanding dietary and dietetic to humans, it has been suggested to added values in rabbit meat by supplemented with high polyunsaturated fatty acids (PUFA) such as linseed or its oil, oat, barley, and fish oil, in the rabbit diet. Since fatty acid profile of the muscle linearly react to the actual feed. Optimum 4% linseed in the diet of rabbit is viewed as sufficient in order to accomplish the enrichment associated with ω-3 fatty acid (Dalle and Szendrő, 2011). The aim of this study was to evaluate the effect of feeding whole linseed on fatty composition and growth performance of rabbits.

Material and Methods

Rabbits, diet and management

Research was carried out to explore the effect of whole linseed enrichment in the feed of growing rabbits (up to 7%) on their performance and composition of fatty acid. A total of forty five rabbits of New Zealand White strains (30±5 days) were purchased from Na-

tional Institute of Health Islamabad, Pakistan and divided into three groups. Diet was only differed in the amount of whole linseed. Rabbits were fed ad libitum until 8 weeks (Table 1).

Table 1: *Formulation of feed (%)*

Ingredients (%)	T_0	T_1	T_2
Alfalfa Fresh	94.0	87.00	90.50
Flaxseed	0.00	7.00	3.50
Calcium-phosphate	1.35	1.35	1.35
Vitamin mineral premixa	1.20	1.20	1.20
Molasses	1.00	1.00	1.00
Salt	0.70	0.70	0.70
Calcium-carbonate	0.70	0.70	0.70
DL-methionin	0.05	0.05	0.05

Slaughtering, sample collection and measurements

At the end of the 8 weeks, the rabbits were slaughtered following the national regulations applied to commercial slaughtering and sampling of loin and hind leg meat was done. Slaughtering of rabbits was carried out on farm by cervical dislocation and after slaughtering samples of the meat (loin, hind legs) was stored at −4°C in a freezer for supplementary exploration. Individual feed consumption (FC) was measured each week for all animals from 30 days of age until 12 weeks of age. Animals were individually weighed on weekly basis. The food conversion ratio (FCR) was estimated between 30 days of age and 12 weeks.

Preparation of sample

5 g sample of meat (loin, hind leg) was put in 25 ml polypropylene tube with a lid. The sample was regimented with the use of lab homogenizer by expending glycerol (20%) and phosphate buffer having pH (7.4) to maintain pH. The regimented loin and hind leg meat samples were centrifuged at speed of 1000 × g for almost 10 minutes that discard the various nuclear segments. Then it was used for further analysis after supernatant was unruffled in a discrete tube.

Fatty acids profile of meat

The fatty acids content of each sample was determined by running samples through GC (Agilent Technologies 6890 N) using Flame Ionization Detector. Nitrogen gas was used as a carrier with flow rate of 1.3 ml/min. The fatty acid profile was estimated conferring to the technique defined by (AOCS, 1998).

Statistical analysis

The data obtained for each parameter was analyzed statistically using MSTAT-C (version 5.2). The Duncan's multiple range (DMR) test was used for determining significance in the mean values (Steet et al., 1997).

Results and Discussion

Rabbit growth performance

Results presented in Table 2 showed that enrichment of 7% flaxseed exert highly significant effect on weight gain of rabbits. T_2 that contains 3.5% flaxseed also showed significant effect. Rabbits that fed on control diet gained minimum weight i.e. 2143g at the end of eight weeks trial. T_1 fed on 7% flaxseed showed maximum weight gain i.e 2334g at the end of trial. The feed conversion ratio (FCR) of the treatment T_1 was 2.94 and the treatment T_0 was 3.16 as shown in Table 3. It means that the group containing flaxseed enrichment increased the performance of rabbit's growth as compared to control diet. The results of this study are against the findings of Ajuyah et al. (1993) who found poorer weight gain and marginally lesser live weight in broiler that were reared on 15% dietary linseed supplementation once associated with a control diet. The scientists linked the poorer weight gain to the existence of various poisonous substances in raw whole flaxseed that may reduce energy consumption.

More recently (Colin et al., 2005) reported a lower live weight and decreased growth at slaughter in rabbits fed linseed using diets containing extruded linseed. This evidence was also originated by Verdelhan et al. (2005) who observed a decreased (-70g) growth performance of rabbits at slaughter by consuming linseed oil in the diet. However, Bernardini et al. (1999) and Dal Bosco et al. (2004) did not notice any harmful effect of linseed on productive performances of rabbits. The results of this study are closely related to the outcomes of Drouillard et al. (2004) who stated that inclusions rate of 5 to 8% flaxseed in the diet increase dietary intake, and an overall average daily gain.

Fatty acid composition

Fatty acid composition of rabbit meat was intensely prejudiced by inclusion of dietary flaxseed. As compared to the general classifications of fatty acids, the flaxseed claimed a lower level of total saturated fatty acids and a higher content of polyunsaturated fatty acids of Loin and leg meat as depicted in Table 4 (Bianchi et al., 2006). Table 4 showed that enrichment of flaxseed raised the concentration of monounsaturated fatty acids (MUFA). T_2 showed higher percentage i.e. 29.42 in loin and 30.85 in case of hind leg. We also

Table 2: *Rabbits weight gain on weekly basis in (g/week)*

Treatment	Week								
	w1	w2	w3	w4	w5	w6	w7	w8	Mean
T_0	593±4.35	803±5.71	1048±6.91	1303±7.11	1538±8.24	1748±9.34	1948±10.01	2143±11.52	1391^{C}
T_1	609±3.68	844±4.83	1114±5.04	1394±6.21	1654±7.41	1889±8.57	2114±9.73	2334±10.95	1494^{A}
T_2	604±4.76	826±5.97	1083±6.23	1350±7.39	1597±8.63	1819±9.71	2031±10.81	2238±11.95	1444^{B}

Different superscripts in a row indicate significant difference between the means ($p \leq 0.05$)

Table 3: *Feed Conversion Ratio (FCR) of the experimental Rabbits*

Treatment	Week								
	w1	w2	w3	w4	w5	w6	w7	w8	Means
T_0	1.71±0.08	2.13±0.01	2.47±0.06	2.98±0.05	3.44±0.03	4.01±0.07	4.17±0.08	4.37±0.08	3.16^{A}
T_1	1.62±0.03	2.01±0.03	2.34±0.05	2.80±0.06	3.20±0.05	3.68±0.04	3.82±0.04	3.98±0.09	2.94^{C}
T_2	1.67±0.05	2.06±0.04	2.40±0.02	2.88±0.05	3.33±0.02	3.83±0.06	3.99±0.06	4.18±0.05	3.05^{B}

Different superscripts in a row indicate significant difference between the means ($p \leq 0.05$)

Table 4: *Fatty acid profile (% of total fatty acid) and fatty acid ratio of selected fatty acid-related indexes*

Fatty acid composition (%)	Fatty acid profile of loin			Fatty acid profile of leg			p-value
	T_0	T_1	T_2	T_0	T_1	T_2	
C14,0	1.22	1.84	1.96	1.80	2.34	2.25	*
C16,0	27.93	26.99	26.87	25.74	24.21	23.91	*
C18,0	6.12	7.47	7.24	5.08	6.38	6.28	ns
SFA	39.26	35.63	36.07	36.61	32.93	32.44	**
C14,1	0.07	0.03	0.20	0.13	0.08	0.06	ns
C16,1	0.61	2.86	3.73	1.77	4.18	3.52	**
C18,1	23.03	24.73	25.48	24.57	26.09	27.27	*
MUFA	23.71	27.62	29.42	26.47	30.35	30.85	**
C18,2	22.82	23.06	24.13	24.02	24.47	26.95	*
C18,3	2.98	5.38	3.55	5.10	8.13	5.57	**
C20,3	7.44	0.26	0.30	7.33	0.16	0.12	**
C22,5	1.18	0.62	0.40	0.74	0.11	0.09	*
C22,6	0.23	0.15	0.19	0.25	0.17	0.11	ns
PUFA	34.65	29.46	28.57	37.44	33.04	32.84	*
UFA	58.36	57.08	57.99	63.91	63.40	63.69	*
SFA/UFA	0.67	0.62	0.62	0.57	0.52	0.51	ns
PUFA/SFA	0.88	0.83	0.79	1.02	1.00	1.01	*

** significant; ** highly significant;* **ns:** *non-significant*

detected increasing levels of n-3 PUFA ($P < 0.001$) from control group (2.98 % in Loin and 5.10 % in leg meat) with respect to groups fed 7% flaxseed (T_1) (5.38% in loin and 8.13% in leg meat), 3.5 % flaxseed (T_2) (3.55% in loin and 5.57% in leg meat) (Bianchi et al., 2009). As evidenced in Table 4 the enhanced concentration of omega 3 poly unsaturated fatty acids was in a position to lower down the n-6/n-3 poly unsaturated fatty acids ratio. α-linolenic acid is the chief fatty acid of flaxseed and the greater concentration of n-3 poly unsaturated fatty acids was mostly due to the enhanced concentration of it. Though Ecosa Pentaenoic acid and Decosahexaenoic acid presented in both meat (loin, hind leg) was too low (0.1%) and it is not growing from control to T_2 group demonstrating that inadequate effectiveness of α-linolenic acid conversion to the long chain n-3 poly unsaturated fatty acids in rabbits. As stressed by (Stanley et al., 2007),

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n-6/n-3 poly unsaturated fatty acids ratio should not use alone. The efficacy of dietary linseed to enhance α-linolenic acid and the poly unsaturated fatty acids and contents of the meat has been formerly testified by various studies on both rabbits (Bernardini et al., 1999) and other species (Maertens et al., 2008). Seeing that 3.5% dietary flaxseed resolute omega 3 poly unsaturated fatty acids of 8.13% of the total fatty acids that present in hind leg. It can be predicted that a content of 396 mg omega 3 poly unsaturated fatty acids /100g meat which signifies about 19% of optional daily allowance (RDA) for omega 3 poly unsaturated fatty acids by (EFSA, 2009).

Conclusions

Flaxseed supplementation significantly enhanced the immunity response of rabbits in order to disease attack by decreasing the mortality of rabbits. Growth parameters like weight gain and FCR were significantly affected by dietary supplementation of flaxseed in feed of rabbits. Enrichment of 7% flaxseed exerted highly significant effect on weight gain of rabbits as compared to other groups. Rabbits that fed on control diet gained minimum weight at the end of eight weeks trial. T_1 rabbits fed on 7% flaxseed showed maximum weight gain at the end of trial. Utilization of 7% flaxseed in the feed of rabbits significantly improved the PUFA concentration in the meat of rabbits. Functional foods should be encouraged in Pakistan for their significance in the improvement of nutrition and curing diseases.

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