EFFECT OF FEEDING BARLEY RADICLE AS FIBER SOURCE ON LIPIDS IN HEN EGGS

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Abstract

The objective of this study to investigate the possibility of improving egg yolk quality using barley radicle, a by product of brewing industry of fibrous nature.

A total of 98 Lohman hens, 54 week old, were used in a 3-month experiment. Hens were randomly allotted into 7 treatment groups (7 replicates of 2 hens). Seven diets formulated by inclusion of barley radicle alone 10 and 20 % BRP or in combination with 5 and 10 % olive cake (OC) as fiber source substituting parts of soybean meal protein and yellow corn,of a control diet.

1-Inclusion of the two levels of BRP in hen diets either alone or in combination with OC resulted in decrease in plasma cholesterol, and triglycerides (TG) .

2-BRP in hen diets at 10% level did not significantly affect total lipids, triglycerides, Phospholipids, cholesterol, LDL and HDL of egg yolk lipids, while 20% BRP alone or in com bination with 5 or 10% OC caused significant decreases in the same parameters.

3-Using BRP in hen diets either alone or in combination with 5 or 10% OC caused decrease in concentration of total saturated fatty acids (SFA) and a remarkable increase in total monounsaturated (MUFA) and polyunsaturated fatty acids (PUFA) in egg yolk lipids, resulting in a decrease in the ratio of n-6 : n-3 fatty acids in egg yolk lipids.

It is concluded that inclusion of BRP up to 20 % either alone or in combination with OC in laying hen diets decreased plasma cholesterol and triglycerides which associated with production of better egg quality. Also, Olive cake a by-product of olive oil industry- contains a high content of crude fiber (300-400g/kg Francisco *et al*., 1989).

Therefore, the objective of this study was to investigate the effects of dietary barley malt rootlets either alone or in combination with olive cake on plasma lipids ; yolk lipids and fatty acids of laying hens.

Materials and Methods

Ninety-eight , 54-week-old, Lohman laying hens were randomly allotted into seven dietary treatment groups each of 14 hens (7 replicates of 2 hens). Seven diets formulated by inclusion of barley radicle protein (BRP) alone or in combination with 5 or 10 % olive cake (OC) as fiber source substituting parts of soybean meal protein and yellow corn of a control diet**.** Diets were formulated to contain 0 % BRP (control) ; 10% BRP ; 20% BRP ; 10% BRP + 5%OC ; 10% BRP + 10% OC ; 20% BRP + 5%OC and 20% BRP + 10% OC respectively (Table 1). All diets were iso-caloric and iso-nitrogenous, covering the nutritional requirements of laying hens (NRC, 1994). Diets, in mash form, and fresh water were supplied *ad libitum*. Birds were housed in cages (2hens/cage) at room temperature and were exposed to 18h light/d. The experiment lasted for 12 weeks. The diets were analyzed for proximate composition (AOAC, 1996).

At the end of the experiment, heparinzed blood samples were collected, via wing vein, from 4 hens/ treatment, chosen at random and plasma was separated by centrifugation and kept frozen at -20^{o}C until analysis for cholesterol (Stein, 1986), triglycerides (Scheletter and Nussel, 1975) and high density lipoprotein (HDL) cholesterol (Viikari and Scand, 1976).

Eggs were collected for chemical analyses during the last 3 days of the experimental period and then weighed and cracked; thereafter, yolks were separated. Three samples of 4 pooled yolks for each treatment were freezed and stored at -20^{o}C before the chemical analyses were performed. Samples of pooled yolk were analyzed for

total lipids (Folch *et al*., 1957), total cholesterol (Shen *et al*., 1982), triglycerides (Lowell *et al*., 1973), high density lipoprotein (HDL) cholesterol (Eckel,1977), low density lipoprotein (LDL) cholesterol (Wieland and Seidel, 1983) and phospholipid (Kates, 1972, Kaur *et al*., 1973).

The lipid extract of pooled yolk samples were pooled in one sample/ treatment. Samples of pooled lipid extract were methylated (Vogel, 1975), FAs were separated and identified using a Pye:Unicam gas chromatography (PU 4550) equipped with dual flame ionization detectors and dual channel recorder: The fractionation of fatty acids methyl esters was conducted using a coiled glass column (1.5m x 4mm) packed with polyethelene glycol adipate (PEGA) 10%). The fractionation condition for fatty acids was as those described by Farag *et al*., (1990). Peak identification for fatty acids was conducted by comparing the retention time with that of a standard of known composition. Peak areas were measured by normalization method and the relative proportions of the individual fatty acids were computed using ATI Unicam 4880 data station.

The effects of dietary treatments were examined using analysis of variance for completely randomized design experiments using SAS (1996), while differences among means were evaluated using Duncan's multiple range test (Duncan, 1955).

Results

Concentration of plasma lipids are shown in Table (2). Inclusion of the two levels of BRP in hen diets either alone or in combination with 5 or 10 % OC resulted in decreases in plasma cholesterol, triglycerides and HDL relative to the control.

The data of the concentrations of egg yolk lipids are shown in Table (3). Inclusion of BRP in hen diets at 10% level did not significantly affect total lipids, triglycerides, Phospholipids, cholesterol or LDL of egg yolk lipids. Results also indicated that inclusion of 20% BRP alone or in compination with 5 or 10% OC caused significant decreases in the same traits compared to the control diet. Results also indicated that the eggs produced from all treatments were free from HDL.

Fatty acid composition of egg yolk lipids are shown in Table (4). Inclusion of BRP in hen diets either alone or in combination with OC caused decrease in the concentration of total saturated fatty acids (SFA) and a remarkable increase in total monounsaturated (MUFA) and polyunsaturated fatty acids (PUFA) in egg yolk lipids , resulting in a decrease in the ratio of n-6 : n-3 fatty acids in egg yolk lipids.

Discussion

The results of the present experiment demonstrate that barley radicle in concentration up to 20% in diets of laying hens , successfully reduced cholesterol lipids and improved fatty acids profile.This could be attributed to high content of CF.and oil content of olive cake (Table 1).

Menge *et al*. (1974) found that addition of 15% cellulose to a standard layer diet decreased serum cholesterol concentration. Bengtsson *et al*., 1990 have proposed that the hypocholesterolemic effect of barley is the result if its β-glucan content, which may possibly increase intestinal viscosity. Moreover, barley fibers have been shown to be effective dietary ingredients for lowering plasma cholesterol in laboratory animals (McIntosh *et al*., 1991). El-Husseiny *et al*. (1997) found that feeding rabbits on diets containing barley rootlets or olive pulp with pit resulted in lowering blood cholesterol.

In accordance with the present results. Turk and Barnett (1971) and (1972) demonstrated that diets of 15% oat hulls or 15% pectin lowered egg cholesterol when fed to laying hens. However, Menge *et al*. (1974) showed that yolk triglycerides were not influenced by the presence or absence of dietary cellulose in leghorn pullets' diets. Laying hens fed barley, produced eggs with less cholesterol than a corn-fed control group (Qureshi *et al*., 1984).

Such great increase in yolk content of total oleic acid (MUFA) , and total PUFA may be a result of feeding olive cake. Leto and Giaccone (1981) reported that oleic acid level increased in the renal fat of rabbits given olive cake than in the control rabbits.

It is concluded that inclusion of BRP up to 20 % either alone or in combination with 5 or 10 %OC in laying hen diets had useful effects on decreasing plasma cholesterol and triglycerides which associated with production of better quality eggs charaterized with great decrease in yolk concentration of total lipids, cholesterol, LDL, triglycerides and phospholipids accompanied with a decrease in the concentration of saturated fatty acids in egg yolk associated with great increases in concentrations of monosaturated (n-9) and polyunsaturated (n-6 and n-3) fatty acids that resulted in decreasing the ratio of n-6 : n-3 fatty acids in yolk lipids.

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Table 1. Feed ingredient and nutrient composition of the experimental diets.

	Control	BRP		10% BRP		20% BRP	
Ingredient, %		10%	20 %	5 % OC	10 % OC	5 % OC	10 % OC
Yellow corn	57.00	57.00	57.00	54.15	51.30	54.15	51.30
Olive cake*	-	0.00	0.00	2.85	5.70	2.85	5.70
Soybean meal (44%)	18.00	16.78	15.55	16.78	16.78	15.55	15.55
Barley radicle**	-	2.55	5.11	2.55	2.55	5.11	5.11
Rice polish	10.00	8.67	7.34	8.67	8.67	7.34	7.34
Fish meal	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Bone meal	2.15	2.15	2.15	2.15	2.15	2.15	2.15
Limes tone	7.00	7.00	7.00	7.00	7.00	7.00	7.00
Vit.& Min. Premix***	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Sodium chloride	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Methionine	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Nutrient analyses							
Crude protein, %	17.61	17.70	17.79	17.62	17.55	17.71	17.64
Crude fiber, %	3.00	3.38	3.89	4.96	6.03	5.02	6.10
Ether extract, %	4.31	4.67	4.93	5.15	6.78	5.48	6.83
ME, Kcal/kg	2779	2773	2767	2768	2761	2761	2755

* 48.2% crude fiber, analitical values
** 16.2% crude fiber, analitical values
*** Vitamin and mineral Premix supplied the following per kilogram of diet: Vitamin A 12.000 IU; Vitamin D_3 2.000 IU; Vitamin E 10 mg; Vitamin K, 2mg; Vitamin B_1 Img; Vitamin B_2 4 mg; Vitamin B_6 1.5 mg; Vitamin B_{12} 10 mcg; Pantothenic acid 10 mg; Niacin 20 mg; Folic acid 1 mg; Biotin 50 mcg; Choline Chloride 500 mg; Iron 30 mg; Manganese 40 mg; Copper 3 mg; Iodine 3 mg; Cobalt 0.2 mg; Zinc 45 mg and Selenium 0.1 mg

Table 2. Effect of inclusion of barley radicle either alone or in combination with olive cake as a source of fiber in laying hen diets on cholesterol, triglycerides and HDL concentration of blood plasma.

	Control	BRP		10% BRP		20% BRP	
Item		10%	20 %	5 % OC	10% OC	5 % OC	10% OC
Cholesterol , mg/dl	$129.3^{a}\pm11.95$	$58.3^{b}\pm5.17$	$86.3^{bc}\pm8.18$	$91.8^{c}\pm6.68$	$99.0^{c}\pm13.3$	$77.5^{bc}\pm15.35$	$83.3^{bc}\pm5.54$
Triglycerides , mg/d l.	$762^{a}\pm12.43$	$561^{c}\pm32.19$	$554^{c}\pm27.93$	$509^{bc}\pm26.97$	$386^{b}\pm65.8$	$403^{b}\pm60.6$	$424^{b}\pm34.2$
HDL, mg/dl	$67.0^{a}\pm4.49$	$17.3^{bc}\pm1.75$	$24.0^{bc}\pm2.48$	$21.5^{bc}\pm0.65$	$25.5^{c}\pm5.48$	$25.8^{c}\pm6.56$	$12.8^{b}\pm0.63$

$^{a, b, c}$ Means in the same row with different letters are significantly different ($P < 0.05$).

Table 3. Effect of inclusion of barley radicle either alone or in combination with olive cake as a source of fiber in laying hen diets on total lipids, triglycerides, Phospholipids, cholesterol, LDL, and HDL of egg yolk lipids.

Composition (per 100g yolk)	Control	BRP		10% BRP		20% BRP	
		10%	20 %	5 % OC	10% OC	5 % OC	10% OC
Total lipids, g	$15.0^{a}\pm0.58$	$14.3^{ab}\pm0.35$	$13.4^{b}\pm0.23$	$13.3^{b}\pm0.26$	$11.2^{c}\pm0.13$	$11.2^{c}\pm0.38$	$9.8^{d}\pm0.63$
Triglyceride, g	$9.75^{a}\pm0.38$	$9.19^{ab}\pm0.14$	$8.74^{b}\pm0.15$	$8.61^{b}\pm0.16$	$7.30^{c}\pm0.06$	$7.26^{c}\pm0.25$	$6.34^{d}\pm0.41$
Phospholipids, g	$3.00^{a}\pm0.09$	$2.87^{ab}\pm0.07$	$2.69^{b}\pm0.04$	$2.65^{b}\pm0.05$	$2.24^{c}\pm0.02$	$2.23^{c}\pm0.07$	$1.95^{d}\pm0.12$
Cholesterol, g	$1.35^{a}\pm0.05$	$1.28^{ab}\pm0.02$	$1.21^{b}\pm0.02$	$1.19^{b}\pm0.02$	$1.01^{c}\pm0.01$	$1.01^{c}\pm0.03$	$0.88^{d}\pm0.06$
LDL, mg	$0.180^{a}\pm0.006$	$0.173^{ab}\pm0.005$	$0.161^{bc}\pm0.003$	$0.156^{c}\pm0.004$	$0.134^{d}\pm0.001$	$0.133^{d}\pm0.004$	$0.117^{e}\pm0.007$
HDL, mg	0.00	0.00	0.00	0.00	0.00	0.00	0.00

$^{a, b, c, d, e}$ Means in the same row with different letters are significantly different ($P < 0.05$

Table 4. Effect of inclusion of barley radicle either alone or in combination with olive cake as a source of fiber in laying hen diets on fatty acid composition of yolk lipids.

Fatty acid, %	Control	BRP		10% BRP		20 % BRP	
		10%	20 %	5 % OC	10 % OC	5 % OC	10 % OC
Caproic acid (6:00)	1.06	0.00	0.16	0.05	0.02	0.00	0.00
Capric acid (10:0)	0.00	0.00	0.00	0.03	0.00	0.00	0.00
Lauric acid (12:0)	0.24	0.00	0.00	0.28	0.05	0.00	0.00
Myristic acid (14:0)	8.07	0.81	0.07	5.68	0.17	0.26	0.65
Palmitic acid (16:0)	29.43	18.47	21.82	12.49	19.59	23.29	21.67
Stearic acid (18:0)	3.37	9.84	6.97	2.74	6.16	7.93	5.80
Oleic acid (18:1 n.9)	2.45	42.25	39.79	38.79	39.30	42.60	47.96
Linoleic acid (18:2 n.6)	3.00	18.08	17.48	18.04	23.58	18.34	18.65
Linolenic (18:3 n..3)	0.10	4.10	0.84	2.80	2.17	1.40	1.06
Arachidic acid (20:0)	0.00	0.00	0.00	3.88	0.27	0.41	0.00
Behenic acid (22:0)	0.00	0.00	7.49	0.00	1.69	1.17	0.00
Total saturated fatty acids	42.17	29.12	36.51	25.15	27.95	33.06	28.12
Total monounsaturated fatty acids	2.45	42.25	39.79	39.79	39.30	42.60	47.96
Total polyunsaturated fatty acids	3.10	22.18	18.32	20.84	25.75	19.74	19.71
n.6 : n.3	30	4.41	20.81	6.44	10.87	13.10	17.59