

# Effects of different levels of fenofibrate on sensory properties and fatty acids profile of breast meat of broilers

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## Abstract

The present study was performed to evaluate the effects of different levels of fenofibrate on the characteristics of broiler meat in a completely randomized design with 3 treatments, 4 replicates and 10 one-day-old male Ross 308 strain chicks per replicate for 42 days. Experimental treatments included 3 levels of fenofibrate (0, 50, and 100 mg/kg), which were used in combination with the basal diet. Analysis of the effect of experimental treatments was performed by SAS statistical software and the comparison of the means at 5% probability level with Duncan's multiple-range test. The results showed that consumption of fenofibrate improved the flavor characteristics of breast meat and the flavor of breast meat increased significantly with the application of 100 mg/kg fenofibrate compared to the control ( $P<0.05$ ). Consumption of fenofibrate increased the percentage of oleic acid and linoleic acid and decreased saturated fatty acids, including palmitic acid and stearic acid in breast meat.

**Key words:** meat, chicken, oleic acid, fibric acid

## Introduction

The accumulation of fat in the body of chickens is an undesirable trait for producers and consumers. Excessive accumulation of fat in the ventricular and visceral areas of poultry indicates the loss of diet and the production of redundant and worthless products economically. In recent years, the consumption of high-fat chickens has been limited by consumers (Emmerson, 1997). Therefore, due to the increasing demand for low-fat protein materials and also solving the problem of fat accumulation in

the body of chickens, it seems that it is necessary to find some strategies to regulate lipids and reduce fat accumulation in poultry bodies (Cabel et al., 1988; Cartwright, 1986; Lien and Horng, 2001; Parsaeimehr et al., 2014). Farrokhyan et al. (2014) and Hosseintabar et al. (2015) demonstrated L-carnitine and gemfibrozil drug have the positive effects on carcass characteristics and blood constituents in meat chicks. Another group of researchers stated that the use of arginine as a regulator of fat metabolism can be

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effective in improving the quality of poultry meat by increasing crispness and brightness, increasing the fat content of muscle and reducing the loss of meat water (Jiao et al., 2010; Wu et al., 2011). There are also some reports stating that effective combinations of medicinal plants can be effective in improving the quantitative and qualitative characteristics of broiler chickens (Schiavone et al., 2007; Luna et al., 2010; Simitzis et al., 2011; Goliomytis et al., 2014). Due to the fact that carcass fatty acids have a significant effect on meat quality (Samadi et al., 2016), it seems that the use of the compounds involved in the metabolism of fatty acids such as blood fat control drugs used for humans can increase the quality of poultry meat and thereby promote human health. Fenofibrate is a derivative of fibric acid and a blood fat-lowering chemical used to lower cholesterol levels in cardiovascular patients. Fenofibrate and fibric acid derivatives reduce fat, very low-density lipoprotein (VLDL), low-density lipoprotein (LDL) and triglycerides, and increase high-density lipoprotein

(HDL) (Yang and Keating, 2009; Ruotolo et al., 1998). Fenofibrate and gemfibrozil are currently one of the most widely available and used fibric acid derivatives on the market (Packard et al., 2002; Yang and Keating, 2009). But so far, the effect of fenofibrate on broiler meat has not been examined. Therefore, this study was conducted to investigate the effect of fenofibrate on the flavor and profile of fatty acids in breast meat of broilers.

## Materials and Methods

In order to investigate the effect of fenofibrate on the diet of broilers, an experiment was performed based on a completely randomized design in 4 replicates and 10 one-day-old male Ross 308 strains chicks per replicate for 42 days. The diet of studied treatments basal diet (without fenofibrate), basal diet + fenofibrate (50 mg/kg of diet) and basal diet + fenofibrate (100 mg/kg of diet).

The fenofibrate used in this study was

**Table 1** Feed ingredients and chemical compounds of diets

Feed ingredient (percentage)	Starter (1-14 days)	Grower (15-28 days)	Finisher (29-42 days)
Maize	47.03	59.60	65.99
Wheat	5.58	5.00	5.00
Soybean meal (44% crude protein)	29.02	16.15	10.28
Corn gluten	10.00	11.48	11.50
Soybean oil	3.50	3.40	3.09
Limestone	1.45	1.23	1.00
Di-calcium phosphate	1.95	1.80	1.83
NaCl	0.20	0.20	0.20
Vitamin and mineral supplements <sup>1</sup>	0.50	0.50	0.50
DL-methionine	0.52	0.58	0.57
L-Lysine Hydrochloride	0.25	0.06	0.04
<b>Calculated nutrients</b>			
Metabolic energy (kcal / kg)	2950	3000	3050
Crude protein (%)	22	20	19
Lysine (%)	1.3	1.2	1.1
Methionine (%)	0.56	0.54	0.52
Methionine + cysteine (%)	0.92	0.90	0.88
Calcium (%)	1.04	0.95	0.92
Available phosphorus (%)	0.52	0.47	0.41

<sup>1</sup> Each kilogram of mineral supplement contained 40,000 mg of manganese, 20,000 mg of iron, 33,900 mg of zinc, 4,000 mg of copper, 400 mg of iodine and 80 mg of selenium. Each kilogram of vitamin supplement contained 3600,000 international units of vitamin A, 800,000 international unit of vitamin D3, 7200 international unit of vitamin E, 710 mg vitamin B1, 2640 mg vitamin B2, 1176 mg vitamin B1, 400 mg vitamin B9, 6 mg vitamin B12, 800 mg vitamin K3, 3920 mg of pantothenic acid, 12,000 mg of niacin, 40 mg of biotin and 200,000 mg of choline chloride.

prepared from Abidi Hygienic Co (Tehran, Iran) and used according to the desired concentrations. The diets were adjusted according to the nutritional needs of commercial Ross 308 strain broiler chickens. The components and composition of the basal diet, including the starter (1-14 days), grower (15-28 days) and finisher (29-42 days) periods are shown in Table 1. Environmental conditions for all groups were similar including 23 Assist. Prof. ours of exposure and one hour of darkness, humidity of 60-75 % and room temperature of 32 °C on the first day, which decreased by 3 °C after each weak. Throughout the period, all chicks had free access to water and feed. Vaccination was performed to prevent bronchitis (1 and 12 days of age), Newcastle disease (10 and 19 days of age) and infectious bursal disease (15, 22 and 28 days of age). All the vaccines were prepared from Razi Pharmaceutical Company (Karaj, Iran).

Other rearing methods was followed based on Seidavi et al. (2014).

To assess the flavor characteristics of the meat, the breast meat of two chickens was cooked for 45 minutes at 180 °C without adding spices and oil. The cooked samples were then numbered and tested with trained people (6-person panel) for scoring of color, aroma, oral sensation, and general acceptance (scale 0 to 100) (Khajavi et al., 2014).

In order to investigate the fatty acid profile of breast meat, 20 g of minced breast meat of two chickens from each replicate were mixed with 50 ml of methanol for 30 minutes. Then 40 ml of hexane was added to it and stirred for 20 minutes. After complete mixing, stirring continued until two phases formed in the sample (Folch et al., 1957). The top layer containing the methyl ester lipid was then analyzed by a gas chromatographic device (Agilent, 6890N, American), employing a capillary column (120 m x 250 µm x 0.2 µm, BPX-70 column) nitrogen carrier gas with

33.3 inlet pressure, an inlet injection temperature of 250 °C, FID detector temperature of 280 °C, and The oven temperature of 198 °C, and the composition of its fatty acids was determined.

## Statistical Analysis

At the end of the experiment, the data were analyzed by SAS statistical software (SAS, 2002). Comparison of the means of treatments was performed with Duncan's multiple-range test at the probability level of 5 %. The design was completely random and its model was as following:

$$Y_i = \mu + A_i + E_i$$

Where  $Y_i$  = observation value;  $\mu$  = mean of community;  $A_i$  = Fenofibrate effect (0, 50 and 100 mg/kg);  $E_i$  = test error effect.

## Results and Discussion

The effect of fenofibrate consumption on the flavor characteristics of breast meat is shown in Table 2. The results showed that there was no significant difference in color, general acceptance and oral sensation with fenofibrate consumption ( $P \geq 0.05$ ), but the flavor and aroma of breast meat was significantly improved by 100 mg/kg fenofibrate ( $P < 0.05$ ). Fenofibrate increases the antioxidant activity and reduces the destructive effects of stress on tissues (Sinha et al., 2018; Poynter and Daynes, 1998). Arnaiz et al. (1997) reported that fenofibrate has increase the activity of endogenous antioxidants in mice; They showed indicated that fenofibrate treatment increases the levels of some endogenous antioxidants such ubiquinol and glutathione in Swiss mice. Therefore, it can be said that the acceleration of antioxidant activity by fenofibrate, as well as the nature of lipid-lowering drugs in facilitating fat metabolism and providing the necessary energy for the bird,

**Table 2** Sensory evaluation of meat mean ( $\pm$ SEM) of Ross 308 broilers at 42nd days of age fed diets containing the different levels of fenofibrate

	Perfume	Taste	Color	Oral sensation	General acceptance
Control	4.500	4.125	4.625	4.290b	3.977b
Fenofibrate (50 mg/kg of diet)	4.875	5.00	4.625	4.375b	4.00b
Fenofibrate (100 mg/kg of diet)	5.625	5.125	5.750	5.625a	5.375a
P-value	0.097	0.192	0.138	0.020	0.023
SEM	0.328	0.386	0.412	0.299	0.330

\* In each column, means with the similar letters are not significantly different ( $P < 0.05$ ). SEM: Standard error of the mean.

all has made it easier for the chickens to have easy access to the nutrients during the breeding period; and the combination of these conditions may have led to meat production with more favorable characteristics for consumers.

The effect of fenofibrate on the profile of fatty acids in breast meat is shown in Table 3. The results showed that by consuming fenofibrate, the amount of stearic acid (C18: 0), oleic acid (C18: 1c) and linoleic acid (C18: 2c) increased and the amount of other fatty acids in breast meat, including palmitic acid (C16: 0), palmitoleic acid (C16: 1) and linoleic acid (C18: 2t) decreased. The results of a study by Montanaro et al. (2005) showed that fenofibrate increased palmitic acid levels and decreased stearic acid in diabetic mice, which contradicts the results of the present study. Schoonjans et al. (1996) believe

that fenofibrate reduces body fat by activating of the peroxisome proliferator-activated receptor  $\alpha$  (PPAR $\alpha$ ). PPAR- $\alpha$  have been implicated in the regulation of lipid metabolism, lipoproteins and glucose homeostasis (Lemberger et al., 1996).

Researchers believe that fat-burning compounds are involved in the production of energy as well as the entry of long-chain fatty acids into mitochondrion by transferring active fatty acids into the mitochondrial matrix, and increase quantitative and qualitative performance of the animal by increasing the efficiency of using the energy from fat oxidation (Dikel et al., 2010; Nogueira et al., 2011). Dikel et al. (2010) stated that the amount of 14- and 18-carbon saturated fatty acids and 15-, 16- and 18- carbon unsaturated fatty acids is increased by

**Table 2** Profile of breast fatty acids Ross 308 broilers at 42<sup>nd</sup> day of age fed diets containing the different levels of fenofibrate

	Lauric acid (C12:0)	Myristic acid (C14:0)	Myristoleic acid (C14:1)	Pentadecanoic acid (C15:0)	Palmitic acid (C16:0)	Palmitoleic acid (C16:1)	Stearic acid (C18:0)	Oleic acid (C18:1c)	Linoleic acid (C18:2t)	Linoleic acid (C18:2c)	$\alpha$ -linolenic acid (C18:3)	Arachidic acid (C20:0)	Cis-Gondoic acid (C20:1)	Behenic acid (C22:0)
Control	0.32	0.87	0.46	0.12	26.99	6.67	5.76	35.23	6.59	15.79	0.51	0.24	0.24	0.21
Fenofibrate (50 mg/kg of diet)	0.24	0.67	0.23	0.1	24.6	5.07	6.76	39.3	5.1	5.1	0.36	0.16	0.17	0.17
Fenofibrate (100 mg/kg of diet)	0.22	0.64	0.20	0.08	24.3	4.56	6.66	40.49	5.12	5.12	0.31	0.14	0.13	0.1

consuming blood lipid control substances in the feed of rainbow trout. The results of various studies show that the use of the chemical drugs effective in controlling blood lipids has no significant effect on the sensory and qualitative characteristics of poultry meat (Corduk et al. 2007; Zhang et al., 2010; Parizadian et al., 2011; Khatibjoo et al., 2016)

## Conclusion

In this study, for the first time, the effect of fenofibrate on the meat characteristics of broilers has been investigated. The results of this study showed that the use of fenofibrate is effective in improving the flavor characteristics of breast meat.

Due to the positive effect of fenofibrate, it is recommended to use 100 mg/kg fenofibrate in the diet of broilers to produce meat with desirable flavor characteristics.

## Acknowledgments

This manuscript is prepared based on PhD thesis of first author at Rasht Branch, Islamic Azad University, Rasht, Iran.

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Delivered: 15.06.2020.

Accepted: 10.07.2020.

## Učinci različitih razina fenofibrata na senzorska svojstva i profil masnih kiselina mesa prsa brojlera

### Sažetak

Istraživanjem smo na potpuno randomiziranom uzorku 10 jednodnevnih muških pilića komercijalnog hibrida Ross308, u tri ciklusa i četiri ponavljanja, tijekom 42 dana, procijenili učinak različitih razina fenofibrata na značajke mesa brojlera. Bazalnoj prehrani u pojedinom je ciklusu dodana jedna od tri različite razine fenofibrata (0, 50 i 100 mg/kg). Analiza učinaka provedena je uporabom programa za statističku analizu SAS, dok je usporedba srednjih vrijednost izvršena Duncanovim testom višestrukog raspona uz vjerojatnost pogreške od 5 %. Rezultati ukazuju da dodatak fenofibrata poboljšava značajke okusa pilećih prsa, pri čemu je dodatak od 100 mg/kg fenofibrata, u usporedbi s kontrolnom skupinom ( $P < 0,05$ ), značajno poboljšao okus pilećih prsa. Dodatak fenofibrata povećao je udio oleinske i linolne kiseline, a smanjio udio zasićenih masnih kiselina, poput palmitinske i stearinske kiseline, u pilećim prsima.

**Ključne riječi:** meso, pilić, oleinska kiselina, fibrinska kiselina

## Auswirkungen verschiedener Fenofibratmengen auf die sensorischen Eigenschaften und das Fettsäureprofil von Broilerbrustfleisch

### Zusammenfassung

Untersucht wurde die Wirkung verschiedener Fenofibratmengen auf die Eigenschaften von Broilerfleisch an einer vollständig randomisierten Stichprobe von 10 eintägigen männlichen Hühnern des kommerziellen Hybrids Ross308 in 3 Zyklen und 4 Wiederholungen in Dauer von 42 Tagen. In jedem Zyklus wurde der Grundnahrung eine von 3 verschiedenen Fenofibratmengen (0, 50 und 100 mg / kg) zugesetzt. Die Effektanalyse wurde unter Verwendung des statistischen SAS-Analyseprogramms durch-

geführt, während der Vergleich der Mittelwerte durch den Duncan-Mehrbereichstest mit einer Fehlerwahrscheinlichkeit von 5% durchgeführt wurde. Die Ergebnisse zeigen, dass die Zugabe von Fenofibrat die Geschmackseigenschaften von Hühnerbrust verbessert, wobei die Zugabe von 100 mg / kg Fenofibrat im Vergleich zur Kontrollgruppe ( $P < 0,05$ ) den Geschmack von Hühnerbrust signifikant verbessert. Die Zugabe von Fenofibrat erhöht den Anteil an Olein- und Linolsäure und verringert den Anteil an gesättigten Fettsäuren wie Palmitinsäure und Stearinsäure in der Hühnerbrust.

**Schlüsselwörter:** Fleisch, Huhn, Oleinsäure, Fibrinsäure

## Efectos de diferentes niveles de fenofibrato sobre las propiedades sensoriales y el perfil de ácidos grasos en la carne de broiler

### Resumen

En una muestra completamente aleatorizada de 10 pollos machos de un día de edad del híbrido comercial Ross 308, en 3 ciclos y 4 repeticiones, durante 42 días evaluamos el efecto de diferentes niveles de fenofibrato en las características de la carne de broiler. A la dieta basal en cada ciclo fue añadido uno de los 3 niveles diferentes de fenofibrato (0, 50 y 100 mg / kg). El análisis del efecto fue realizado utilizando el programa de análisis estadístico SAS, mientras que la comparación de los valores medios se realizó mediante la prueba de rango múltiple de Duncan con una probabilidad de error del 5%. Los resultados indican que la adición de fenofibrato mejoró las características de sabor de la pechuga de pollo, donde la adición de 100 mg / kg de fenofibrato mejoró significativamente el sabor de la pechuga de pollo, en comparación con el grupo de control ( $P < 0,05$ ). La adición de fenofibrato aumentó la proporción de ácido oleico y linoleico, y disminuyó la proporción de ácidos grasos saturados, como el ácido palmítico y esteárico, en la pechuga de pollo.

**Palabras claves:** carne, pollo, ácido oléico, ácido fibrínico

## Impatto dei differenti livelli di fenofibrato sulle proprietà sensoriali e sul profilo degli acidi grassi della carne del petto di pollo

### Riassunto

Questa ricerca è stata svolta su un campione completamente randomizzato di 10 pulcini maschi di un giorno dell'ibrido commerciale Ross 308, in 3 cicli e 4 ripetizioni, durante 42 giorni. Con essa abbiamo valutato l'impatto di differenti livelli di fenofibrato sulle caratteristiche della carne dei polli da carne. Al mangime base in ogni singolo ciclo è stato aggiunto uno dei 3 differenti livelli di fenofibrato (0, 50 e 100 mg/kg). L'analisi dell'impatto è stata condotta con l'impiego del programma d'analisi statistica SAS, mentre la comparazione dei valori medi è stata eseguita con il test di comparazione multipla di Duncan con probabilità d'errore del 5%. I risultati hanno dimostrato che l'aggiunta del fenofibrato migliora le caratteristiche del gusto del petto di pollo, laddove l'aggiunta di 100 mg/kg di fenofibrato, rispetto al gruppo di controllo ( $P < 0,05$ ), ha migliorato significativamente il gusto dei petti di pollo. L'aggiunta del fenofibrato nei petti di pollo ha aumentato la percentuale di acido oleico e linoleico, mentre ha diminuito la presenza di acidi grassi, come l'acido palmítico e stearico.

**Parole chiave:** carne, pulcino, acido oleico, acido fibrinico