RESPONSE OF EGG PRODUCTION AND EGG SHELL QUALITY TO DIETARY VEGETABLE OILS

By

MAHAMADOU ISSOUFOU HASSANE
B.Sc. Agric. Sci. (Animal Prod.), Fac. Agric. (Cairo), Al-Azhar Univ., 2005

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APPROVAL SHEET

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ABSTRACT

An experiment was conducted to examine the effect of dietary linseed oil, palm oil and sunflower oil levels and their interactions on laying hen performance, egg quality and economic efficiency. The oils were used to substitute 2.4 % or 4.8 % of the diet. the diets were fed to 810 Bovans White laying hens, 30 weeks of age for 16 wks, which were, divided randomly into 15 groups of 54 hens in 3 replicates of 18 hens each. T1 was consider as control group (Cont.). Experimental groups were offered diets having 2.4 % or 4.8 % of either linseed oil (LO) or palm oil (PO) or sunflower oil (SFO). (1:1) mixture of LO + PO, LO + SFO or PO + SFO, respectively. And (1:1:1) mixture of LO + PO + SFO. Body weight, Egg production, egg weight, feed intake, egg internal and external quality characteristics were recorded. It can be concluded that the vegetable oil had positive effect on hen performance. Feeding laying hens on PO + SFO diet at 2.4 % substitution produced the best egg production. Egg weight tends to increase with oil addition. The diets containing PO at 4.8 % or PO + SFO at 2.4 or 4.8 % substitution, recorded the best feed conversion ratio. No significant differences between dietary oil sources or levels on egg shell thickness and percentage, total lipid or total cholesterol contents in the yolk and albumen mixture compared to the control diet. All oil sources improved egg shell weight when compared to control diet. Significant differences omong dietary treatments on serum total immunoglobulin titres were observed. The diet containing PO + SFO at 2.4 % substitution level had the highest relative economic efficiency compared to the control diet. Vegetable oil improved the digestion coefficient values of almost all of the nutrients. Addition of 4.8% vegetable oil resulted in a significant ($P < 0.05$) increase in egg yolk SFA with a concomitant reduction in egg yolk MUFA. Oleic acid ($C_{18:1}$) was the dominant fatty acid in all groups, followed by palmitic ($C_{16:0}$) and LA ($C_{18:2}$). A rise in LO in the diet resulted in an increase in LNA ($C_{18:3}$)concentration in the yolk lipids.

Key words: Laying hens, egg production, egg quality, vegetable oils.

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INTRODUCTION

In most developing countries such as Egypt, there is a big gap between available and required amounts of the grains for poultry feed, the main reason of this gap is the extensive poultry production especially egg production due to the extensive increase in human population and increasing their demands of animal products such as meat and egg. The considerable increase in the cost of poultry diets in Egypt has necessitated a search for cheaper sources of dietary energy to particully replace the cereals traditionally used in poultry diets. Lipids (fats and oils) are one of these sources which can be used in poultry diets. Besides, fats can serve as a source of the fat soluble vitamins, A, K, E and D in addition to the polyunsaturated fatty acid such as linoleic acid which cannot be synthesized by the animal and therefore, very necessary proper functioning of many metabolic processes. Although, the effect of feeding unsaturated fats on laying hen has been studied by several workers, only little has compared saturated vs. unsaturated fats and fatty acids and their utilization by laying hens.

Fat is considered to be a practical and economical means to increase energy levels in poultry diets. The incorporation of animal fat and vegetable oil sources in balanced levels to laying hen diets has often influenced feed intake and conversion, egg quality and quantity and other egg production parameters. Whether it is practical or not, adding fat to the poultry diets depends upon the relative prices of the grains and of the available oils. The addition of fat to diets, besides supplying energy, improves the absorption of fat-soluble vitamins, increases the palatability of the rations, and increases the efficiency of the consumed energy (lower caloric increment). Moura (2003) reported that chickens fed rations containing oil showed better performance than birds fed diets without oil inclusion. Egg production improved by adding vegetable oil to laying hen diet (Augustyn *et al*., 2006 and Celebi and Utlu, 2006). García-Rebollar *et al*. (2008) found no effect of linseed oil or marine fish oil on shell thickness. Suksombat *et al*. (2006) found that Shell thickness was not influenced by the dietary conjugated linoleic acid. Millet *et al*. (2006) observed that dietary fat source did not influence cholesterol content in the yolk or in the total egg.

The experiment was designed to evaluate the effect of some energy sources from vegetable origins, at two substitution levels 2.4% or 4.8% and their mixtures from the diet on laying hen performance, egg quality, immune response, nutrients utilization, economic efficiency of egg production and egg yolk fatty acid.

The present work aimed to study the effect of some vegetable oil, at two substitution levels (2.4% or 4.8%) of the diet, on egg production, especially from the economic point of view and the egg quality of egg produced with emphasizing on their contents of total lipids and total cholesterol.

CONTENTS

LIST OF ABBREVIATIONS

AA	Arachidonic acid
AOAC	Association of Official Agriculture Chemists
^{0}C	Celsius degree
CF	Crude Fiber
CLA	Conjugated linoleic acid
cm	Centimeter = 10^{-2} meter
CP	Crude protein
DHA	Docosahexaenoic acid
DM	Dry matter
EE	Ether extract
EPA	Eicosapentaenoic acid
FFSB	Full-fat soybean
g	Gram = 10^{-3} kilogram
HDL-Chol	High density lipoprotein cholesterol
HO-SFM	High oil sunflower meal
HO-SFO	High oleic sunflower oil
Kcal	Kilocalorie = 10^3 calorie
Kg	Kilogram = 10^3 gram
LA	Linoleic acid
L.E.	= 1 Pound Egyptian currency = 100 Piasters
LDL-Chol	Low density lipoprotein cholesterol

LNA	Linolenic acid
LO	Linseed oil
ME	Metabolizable energy.
mg	Milligram = 10^{-3} g
mm	Millimeter = 10^{-3} meter
MUFA	Monounsaturated fatty acid
NFE	Nitrogen free extract.
NRC	National Research Council
NPN	Non protein nitrogen
NPP	Non phytate phosphorus
OM	Organic matter.
PGE2	Prostaglandin E2
PKM	Palm kernel meal
PO	Palm oil
PUFA	Polyunsaturated fatty acid
SFA	Saturated fatty acid
SFO	Sunflower oil
SSS	Soybean soapstock
TMEn	Nitrogen corrected true metabolizable energy
ω	Omega
WKs	1 Week = 7 days

REVIEW OF LITERATURE

1. Fatty acid classification

Fatty acids are classified according to carbon chain length and degree of saturation (as defined by the number of double bonds in the molecule). Nutritionists also identify which "omega" family an unsaturated fatty acid belongs to, ω3, ω6 or ω9, by the position of the first double bond on the carbon chain counting from the methyl end of the molecule. Fatty acids can be classified as saturated (no double bonds), monounsaturated (one double bond) or polyunsaturated (two or more double bonds). Woods *et al*. (2005)

a. Saturated fatty acids

Saturated fatty acids (SFA) are those that have no double bonds and are considered as the 'bad' fatty acids, in that they increase serum cholesterol in humans (Bruckner, 1992). Stearic acid ($C_{18:0}$) is a saturated fatty acid that has different biological effects than other saturated fatty acids and is considered to have a neutral effect on cholesterol levels. Its main sources are animal fats, vegetable oils and chocolate (Dietary Guidelines Advisory Committee Report, 2005).

b. Unsaturated fatty acids

Unsaturated fatty acids, with double bonds, are the more 'beneficial' fatty acids in terms of human health, and have many health benefits attributed to them. The main sources of unsaturated fatty acids are vegetable oils although there are also some in animal products, such as meat and dairy products. Unsaturated fatty acids can be further broken down into monounsaturated fatty acids (MUFA) or polyunsaturated (PUFA) as follows (Woods *et al*., 2005).

1. Monounsaturated fatty acids

Monounsaturated fatty acids contain only one double bond in their chemical composition. Vegetable oils e.g. canola oil, olive oil, high oleic safflower and sunflower oils and nuts are rich in MUFA (Dietary Guidelines Advisory Committee Report, 2005).

2. Polyunsaturated fatty acids

Polyunsaturated fatty acids have two or more double bonds, and may be of two types, based on the position of the first double bond.

2. Biosynthesis of fatty acids

a. Elongation and desaturation

Biosynthesis of long-chain PUFA in mammalian cells occurs through a sequence of alternating desaturation and chain-elongation reactions acting on the dietary fatty acid precursors, linoleic acid 18:2ω6 and linolenic acid 18:3 ω3 (LNA) see Figure 1.1. The same elongation and desaturation pathway involving 24-carbon intermediates and peroxisomal retroconversion is utilized by ω3 and ω6 PUFA. Arachidonic acid 20:4ω6 (AA), the major product of the ω6 series, generates from 18:2ω6 by the sequential action of Δ6-desaturase, an elongase and Δ5-desaturase. The same pathway acting on 18:3ω3yields EPA (20:5ω3) and DHA (22:6ω3), the most abundant PUFA of the ω3 series. The rate limiting step in the enzymatic pathways of PUFA biosynthesis is thought to be Δ6-desaturase. The commonly accepted pathway for the synthesis of DHA (22:6ω3) consists of the elongation of 20:5ω3 to 22:5ω3 followed by a Δ4-desaturation. Whereas, saturated fatty acids (palmitic 16:0 and stearic 18:0 acids) are converted to mono unsaturates (oleic 18:1 acid) by Δ9-desaturase (Woods *et al.*, 2005).