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REGULAR ARTICLE

EFFECT OF USING PACKED FAT, RAPESEED AND SUNFLOWER OIL IN BROILER DIET ON ORGANIC CHEMICAL COMPOSITION OF MUSCLES AND LIVER

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ABSTRACT

The objective of the present study was to research the effect of diffrent type and level of fat on organic chemical composition of meat quality. For both sexes of broiler (Ross-308), in breast and thigh meat also liver were investigated. One-day 800 chickens were divided to four testing groups C 5% packed fat, T1 2.5 % packed fat +2.5% sunflower oil, T2 2.5% packed fat +2.5% rapeseed oil, and T3 2.5% packed fat +1.25 rapeseed +1.25% sunflower oil. Each group has 4 replication's. The length fattening was 42 days. Higher proportion of dry matter (DM) found in thigh female in T2 ((27.37%) and for male was (26.34%) in T1. Higher protein content in the breast for female was in T1 (21.09%) and for male was in T2 (20.61). liver protein value for female was highest in group C (16.51%) while for male was in T2 (16.91%) . Lower fat content in the breast was in group T1 for female (1.06%) and for male was in T2 (1.22%). In thigh muscle lowest fat value for female and male were in group C (4.54%, 4.23%) respectively. High value for total Ash in the liver was in group T1 for female, and in group T2 (1.12%) for male. Cholesterol proportion was found in the C group compared to other groups for all parameters of breast, thigh and liver with both sexes.

Key words: broiler, organic chemical of meat quality, and human health

INTRODUCTION

The science of nutrition involves providing a balance of nutrients that best meets the animal needs for growth, maintenance egg production, etc. For economic reasons, this supply of nutrients should be at least coast, and so we must supply only enough for requirements, without there being any major excesses. It is very difficult and very expensive to supply all nutrients at the exact nutrient needs rather we have to oversupply some nutrients in practical situation, in an attempt to meet the limiting nutrients. In poultry diets these limiting nutrients are usually energy and some of essential amino acids such as methionine and lysine. In formulating diets the following nutrients are considered energy, protein, fat, vitamins, mineral and water (**Mohammed *et al.,* 2005**). However, the chemical structures of fats and oils are extremely variable, with consequences for digestibility and the ultimate accuracy of diet formulation. Oils of plant origin, such as soybean oil (SO), contain high levels of unsaturated fatty acids and are completely digested by fowl along with animal fats such as lard and tallow (T), which contain higher proportions of saturated fatty acids (**Sklan, 1979; Corino *et al.,* 1980; Leeson and Atteh, 1995**). In addition, the age of birds has a marked influence on the utilization of dietary fats. Birds' physiological ability for fat utilization is poorly developed in the early growth stage, but greatly improves with age (**Carew *et al.,* 1972; Freeman, 1984**). Nonetheless, most previous studies using the ME and digestibility bioassay of fats were performed with adult cockerels, although the commercial value resides in the formulation of diets for broilers (**Carew *et al.,* 1972; Freeman, 1984; Mc Nab and Blair, 1988; Wiseman and Salvador, 1989**). Developments over the past few years on the nutritional properties of dietary fats have created considerable excitement, not only in medicine and health care but in the vegetable oil industry as well. Several of these developments have important significance to the canola industry. They are recommendation that dietary fat can be reduced to 30% and saturated fat to less than 10% of the total energy in the diet. For example, it makes up 45 to 50% of the calories for the breast-fed human infant. Fat also serves as the source of essential fatty acids and as a carrier for the fat soluble vitamins. It contributes to the palatability of food and to the feeling of safety. Interest has centered on the role

of both the amount and type of fat in the development of these diseases **(Bruce, 2010).** A new study is suggesting, that people who eat more red and processed meat may have a mortality increased risk of death from all causes and also from cancer or heart disease over a 10-year period. In contrast, a higher intake of white meat appeared to be associated with a slightly decreased risk for overall death and cancer death **(Crespo and Garcia, 2002).**

Atherosclerosis and cholesterolemia are two of the major causes of human death. These diseases are assumed to be influenced by diets of highly saturated fatty acids and cholesterol. Therefore attempts have been made to produce low cholesterol meat and eggs. Many methods including the supplement of copper (Cu), chromium (Cr) and polyunsaturated oils (PUFO) were reported **(Suchon *et al.*, 2007).** There is increasing evidence, that dietary monounsaturated fatty acid enrichment has a positive effect on cardiovascular health, decreasing low-density lipoprotein cholesterol but not high-density lipoprotein cholesterol in blood plasma, and decreasing the susceptibility of low-density lipoprotein to oxidation **(Grundy, 1986, Roche, 2001).**

The objective of our study was study of utilization of different fats in broiler nutrition's illustrating the affect of each type on broilers' chemical composition of meat characterized to be found on reflections on human health considerations.

MATERIAL AND METHODS

The experiment was realized at the test station poultry of Slovak Agricultural University in Vígľaš; research farm on feeding of Ross 308 chicken hybrid combination. The experiment enrolled 800 pieces of one day chickens hybrid combination and were created 4 groups of animals: control (C) and three experimental (I, II and III) of 50 pcs of chickens. Custom feeding insisted 42 days. Chickens are housed in the experimental procedure under the same technological conditions. Viewed climatic variables must meet the criteria for the type and category of animals. Other technology systems (ventilation, lighting intensity, length of day light) implemented as recommended by the fattening technology applicable to a particular hybrid chicken included in the experiment.

The feed formulation and feeding periods

Isocaloric and isonitrogenous diets formulated by the use of the program (G7 2000) are based on least cost design.

Feeding by compound feed

Feed mixture will be loose fed, without other feed *ad libitum*. Fresh, hygienic drinking water will still be available from automatic drinker. Production, sampling and analytical were assessment the feed mixtures. Feed mixture will be produced under the supervision of staff research team at the BTS Vígľaš; the production will be equalized in bags. Compound feed production will be sampled after taking subsamples for bagging.

The sub-samples will be prepared bulk sample, which will be adjusted to an appropriate reduction in the size of laboratory samples. Feed should be sampled official sampling procedure under Regulation (ES). 152/2009 laying down methods of sampling and analysis for official controls on feed. Analytical evaluation of the feed will be carried out in laboratories of the Central Control and Testing Institute in Agriculture (ÚKSÚP) Zvolen, in scope as stated in the "Viewed indicators. Recipes complete feed mixtures were designed by ÚKSÚPu, sponsor experiment suggested dosage product verification. To calculate the nutritional value of compound feed materials were used with the following content of crude protein: 70.0 g maize / kg, 107.1 g wheat / kg, soybean meal 460.4 g / kg and 619.5 g fishmeal / kg. Feed formula shall be adjusted for the analytical determination of individual nutrients in feed materials, if necessary premix additives. In developing the final formula will be followed so that the compound meets the requirements of type- Slovakia government under Regulation number. 440/2006 on feed mixtures in compliance with the experimental intervention consisting of doses of fat and vegetable oils with incorporating Packed Fat (commercial name of Animal Fat boiling to be liquid due to easy use in feed mixture) , Sunflower oil and Rapeseed oil into broiler starter and diet. The feeding duration is 7 days for prestarter, 9 days for starter, 17 days for grower, and 5 days for finisher. Diets were provided *ad libitum*. The feed mixtures formulated for each period of feeding and chemical analysis of the feed mixtures presented in tables 1, 2, 3, and 4.

Table 1 Pre-starter feed mixtures formula and chemical analysis

Components		Groups % C	T1	T2	T3
Maize	%	44.20	44.20	44.20	44.20
Soybean meal		32.00	32.00	32.00	32.00
Wheat		10.00	10.00	10.00	10.00
Fishmeal		5.00	5.00	5.00	5.00
Limeston($Ca\ Co_3$)		1.35	1.35	1.35	1.35
monocalcum phosphate		1.00	1.00	1.00	1.00
*PX BR Unit		1.00	1.00	1.00	1.00
Methionen 99%		0.12	0.12	0.12	0.12
Total salt		0.20	0.20	0.20	0.20
Therionine 99 %		0.13	0.13	0.13	0.13
Packed fat		5.00	2.50	2.50	2.50
Sunflower oil		-	2.50	-	1.25
Rapeseed oil		-	-	2.50	1.25
TOTAL		100.00	100.00	100.00	100.00
Chemical composition					
Crude protein	%	23.69	23.17	23.36	23.48
Crud fat		7.57	8.03	8.09	8.23
Crude fiber		2.8	2.6	2.9	2.9
Ash		6.31	6.43	6.45	6.33
Calcium		11.023	11.920	11.582	11.107
Total phosphor	$mg.kg^{-1}$	7.417	7.500	7.417	7.500
Sodium		18.1	18.2	19.0	18.5
Magnesium		2.202	2.326	2.268	2.238
ME_N	$MJ.Kg^{-1}$	12.702	12.946	12.811	13.140

Legend: *vit. A=4,500,000 IU, vit. D=1,660,000 IU, vit. E=20,000 $mg.kg^{-1}$, vit. K3=1, $mg.kg^{-1}$, vit. B1=1,800 $mg.kg^{-1}$, vit. B2=2,500 $mg.kg^{-1}$, vit. B6=1,600 $mg.kg^{-1}$, vit. B12=8.75 $mg.kg^{-1}$, folic acid=600 $mg.kg^{-1}$, calcium pentonite=5,500 $mg.kg^{-1}$, niacinamid=18,000 $mg.kg^{-1}$, biotin=60 $mg.kg^{-1}$, cholin clorid=30,000 $mg.kg^{-1}$, betain=65,000 $mg.kg^{-1}$, cobalt=150 $mg.kg^{-1}$, Iodine=380 $mg.kg^{-1}$, Mn=45,800 $mg.kg^{-1}$, cupper=6,500 $mg.kg^{-1}$, Si=110 $mg.kg^{-1}$, Zn=28,300 $mg.kg^{-1}$,Fe=27,200$mg.kg^{-1}$, Mo=350 $mg.kg^{-1}$.

Table 2 starter feed mixtures formula and chemical analysis

Components		Groups % C	T1	T2	T3
Maize	%	48.50	48.50	48.50	48.50
Soybean meal		29.00	29.00	29.00	29.00
Wheat		10.00	10.00	10.00	10.00
Fishmeal		4.00	4.00	4.00	4.00
Limeston($Ca\ Co_3$)		1.30	1.30	1.30	1.30
monocalcum phosphate		0.85	0.85	0.85	0.85
PX BR Unit		1.00	1.00	1.00	1.00
Methionen 99%		0.05	0.05	0.05	0.05
Total salt		0.22	0.22	0.22	0.22
lysine		0.03	0.03	0.03	0.03
Therionine 99 %		0.05	0.05	0.05	0.05
Packed fat		5.00	2.50	2.50	2.50
Sunflower oil		-	2.50	-	1.25
Rapeseed oil		-	-	2.50	1.25
TOTAL		100.00	100.00	100.00	100.00
Chemical composition					
Crude protein	%				
Crud fat		22.01	21.46	21.76	22.06
Crude fiber		7.63	8.91	7.88	8.00
Ash		2.3	3.0	2.4	2.2
Calcium		5.94	6.93	6.01	5.98
Total phosphor	$mg.kg^{-1}$	10.943	13.772	10.785	10.665
Sodium		7.500	7.417	6.917	7.084
Magnesium		18.10	18.20	19.00	18.50
ME_N	$MJ.Kg^{-1}$	2.236	2.499	2.143	2.227
		12.950	13.057	13.052	13.208

Table 3 grower feed mixtures formula and chemical analysis

Components		Groups % C	T1	T2	T3
Maize	%	42.40	42.40	42.40	42.40
Soybean meal		29.00	29.00	29.00	29.00
Wheat		20.00	20.00	20.00	20.00
Limeston($Ca\ Co_3$)		1.35	1.35	1.35	1.35
monocalcum phosphate		0.80	0.80	0.80	0.80
*PX BR Unit		1.00	1.00	1.00	1.00
Methionen 99%		0.05	0.05	0.05	0.05
Total salt		0.33	0.33	0.33	0.33
lysine		0.02	0.02	0.02	0.02
Therionine 99 %		0.05	0.05	0.05	0.05
Packed fat		5.00	2.50	2.50	2.50
Sunflower oil		-	2.50	-	1.25
Rapeseed oil		-	-	2.50	1.25
TOTAL		100.00	100.00	100.00	100.00
Chemical composition					
Crude protein	%	19.28	19.89	19.20	19.35
Crud fat		7.36	7.54	7.41	7.64
Crude fiber		2.8	3.0	3.0	2.5
Ash		5.76	5.63	5.63	5.67
Calcium		10.943	13.772	10.785	10.665
Total phosphor	$mg.kg^{-1}$	7.500	7.417	6,917	7.084
Sodium		16.00	15.50	16.70	16.30
Magnesium		2.236	2.499	2,143	2.227
ME_N	$MJ.Kg^{-1}$	1.3	1.3	1.3	1.3

Table 4 finisher feed mixtures formula and chemical analysis

Components		Groups % C	T1	T2	T3
Maize	%	40.50	40.50	40.50	40.50
Soybean meal		22.60	22.60	22.60	22.60
Wheat		28.00	28.00	28.00	28.00
Limeston($Ca\ Co_3$)		1.35	1.35	1.35	1.35
monocalcum phosphate		0.80	0.80	0.80	0.80
*PX BR Unit		1.00	1.00	1.00	1.00
Methionen 99%		0.20	0.20	0.20	0.20
Total salt		0.30	0.30	0.30	0.30
lysine		0.15	0.15	0.15	0.15
Therionine 99 %		0.10	0.10	0.10	0.10
Packed fat		5.00	2.50	2.50	2.50
Sunflower oil		-	2.50	-	1.25
Rapeseed oil		-	-	2.50	1.25
TOTAL		100.00	100.00	100.00	100.00
Chemical composition					
Crude protein	%	17.73	17.86	17.61	17.76
Crud fat		7.30	7.26	7.51	7.37
Crude fiber		2.5	2.4	2.8	2.4
Ash		5.39	5.39	5.44	5.45
Calcium		10.366	10.739	10.467	10.273
Total phosphor	$mg.kg^{-1}$	6.367	6.100	5.834	6.00
Sodium		14.4	14.2	13.5	15.8
Magnesium		2.293	2.296	2.285	2.236
ME_N	$MJ.Kg^{-1}$	1.3	1.3	1.3	1.3

Trial management

Broiler chickens were kept under the Ross recommended procedure. Water and rations distributed *ad libitum* and uniform light provide 24 hours daily. The temperatures of the house and vaccination programme applying are basing on broiler live breeding period raisers' recommendations. Chickens in the course of the trial were housed on the deep litter in the same

technological conditions. Microclimate indicators in the range of temperature and humidity were measured and recorded three times a day, at 7.00 am, 12.00 and 17.00 pm.

Measurement indicated in the zone of animals, in the height from the floor, where the largest part of the body of animals.

Experimental procedures

Meat quality

The basic chemical analysis of the muscles was determined and represented in percentage in the meat. Macro minerals were determined and represented in $g.kg^{-1.}$

Mortality

It is recorded weekly and calculated percentages are obtained by dividing the total number of the mortality during each of week for breeding period on 7.

Methods used for chemical analysis of feeds mixtures and some carcass parts

Determination of total nitrogen (Crude protein)

The determination of nitrogen in feeds, meat and liver was performed with the macro-Kjeldahl method according to application of ISO 5983-2 (2009) standard method for block digestion and steam distillation and ISO 5983-1 (2005) standard method for Kjeldahl method by using Leco NS, nitrogen analyzer (LECO Corporation, St. Joseph, MI).

Determination of total fat

Total fat content of meat and liver was determined by application of ISO- 11085 (2008) standard method. The brief procedure of crude fat analysis was explained in the appendix. Fatty

acids analysis was prepared by modification method of ISO/ TS 17764-1 (2002). The brief procedure of analysis and fatty acids content in feeds were explained in the appendix.

Crude fiber, starch and total sugar determination

Determination of the content of crude fiber was applied by the use of ISO 6865 (2000) standard method with intermediate filtration. Starch content analyzed by polar meter method ISO 6493 (2000). The brief procedure of starch analysis was explained in the appendix. For determination of total sugar the Slovak norm 1971/250/EHS of standard method was applied.

Basic nutrients determination in the meat

Dry matter (DM) by the thermal method (105^{o}C) acc to Slovak Standard method ISO 1442 (2000). The crude protein content (CP) by the Kjeldahl method, acc. To Slovak Standard method 75/A-04018 (1975). Crude fat (CF) by the Soxhlet, ac, to Slovak Standard method ISO 1444 (2000). Crude ash (CA) acc, to Slovak Standard PN-72/A-82245 (1972).

Statistical analysis

For the statistical design and data analyses, complete random design an experiment with 4 treatments were determined. Data in all experiments were subjected to ANOVA procedures appropriate for a completely randomized design and the significance of differences between the means estimated using Duncan test (Duncan's new multiple range test). Probability level of $P<0.01$ was considered for Significance in all comparisons. Values in percentage were subjected to transformation of Arc sin v100. All statistical analyses were performed using the software SPSS 17.5 for Windows® (SPSS Inc., Chicago, IL).

RESULTS AND DISCUSSION

Effect of diets on the chemical composition of the muscle and the liver

Food safety is the foundation of the future of the poultry industry and the total food chain issue bears great responsibility to consumers.

Effects of diets on chemical composition of breast muscle.

The supplementation of dietary mixtures for poultry with different fat type has been practiced for some time. However, due to consumer requirements, the physico-chemical characteristics of the meat should also be considered, not just the production effects on breeding. Chicken meat is very important in the human food industry. Chemical compositions of breast muscle for trial groups are present in table 5.

Table 5 Mean ±SD of chemical composition of breast and thigh muscle and liver of chickens in different dietary treatments

Attributes	Dietary treatments							
	C		T1		T2		T3	
	Breast muscle							
	Female	Male	Female	Male	Female	Male	Female	Male
Dry matter %	25.76±0.65	26.10±0.18	26.50±0.33	26.22±0.58	26.75±.45	25.86±0.80	26.01±0.12	25.88±0.20
Crude protein %	20.41±0.14	20.41±0.14	21.09±0.27	20.55±0.24	20.87±0.39	20.61±0.93	20.68±0.76	20.53±0.26
Ether extract %	1.10±0.42	1.54±0.33	1.06±0.14	1.76±0.55	1.73±0.59	1.22±0.46	1.17±0.14	1.26±0.30
Total ash %	1.21±0.03	1.19±0.01	1.26±0.05	1.19±0.04	1.22±0.02	1.21±0.04	1.21±0.05	1.21±0.04
Cholesterol mg.100g^{-1}	55.0±0.55^{c}	58.23±0.36^{d}	46.90±3.6^{b}	45.63±4.46^{c}	34.93±2.4^{a}	39.88±0.83^{b}	36.78±4.5^{a}	34.63±1.37^{a}
Thigh muscle								
Dry matter %	25.26±0.88	24.85±1.03	26.44±0.49	26.51±1.06	26.38±1.07	25.63±0.94	26.00±0.67	26.65±0.29
Crude protein %	17.33±0.34	17.40±0.31	17.71±0.34	17.32±0.29	17.72±0.59	17.42±0.44	17.53±0.18	17.45±0.30
Ether extract %	4.54±1.04	4.23±0.74	5.35±0.38	5.60±0.89	5.22±1.54	5.15±0.87	5.06±0.58	4.84±0.23
Total ash %	1.11±0.03	1.10±0.01	1.15±0.03	1.09±0.04	1.12±0.03	1.12±0.03	1.11±0.02	1.11±0.01
Cholesterol mg.100g^{-1}	60.38±0.4^{c}	64.90±0.95^{b}	48.43±4.4^{b}	54.30±2.24^{c}	49.33±0.8^{b}	49.35±0.55^{c}	41.13±1.3^{a}	45.05±1.26^{a}
Liver								
Dry matter %	26.62±0.91	25.69±0.97	26.41±0.82	26.34±0.97	27.37±0.87	26.27±0.34	27.08±0.56	26.23±1.12
Crude protein %	16.51±0.54	16.81±0.31	16.31±0.62	16.50±0.38	15.90±0.80	16.91±1.72	15.12±0.45	15.78±0.97
Ether extract %	4.31±1.20	3.15±0.27	6.44±0.84	3.22±1.08	4.24±0.47	3.06±0.32	4.14±1.14	3.09±0.39

Total ash %	1.34±0.6	1.356±0.01	1.35±0.04	1.38±0.017	1.36±0.04	1.37±0.02	1.34±0.3	1.36±0.04
Cholesterol mg.100g^{-1}	64.58±1.2^{d}	51.70±3.40	58.03±2.3^{c}	59.58±2.34	52.25±2.5^{b}	50.65±1.07	47.33±6.8^{a}	49.20±0.79

Legend: ^{a,b} means with different superscript within row are significantly different (P< 0.05) and values will increase from a to c value.

Values are $\bar{x}$ ± Std. Deviation of 50 birds

The alimentary value of poultry meat is higher than that of large slaughter animals' meat, since it includes less cholesterol, collagen and total fat **(Kroliczewska *et al.*, 2008).** Obtaining proper quality poultry meat depends not only on genetic potential but also on alimentary factors **(Kang *et al.*, 2001).**

The breast muscle has not affected significantly (P<0.01) by addition of packed fat and mixing with rapeseed or sunflower oil additives in the case of dry matter, crude protein and ether extract and total Ash. The dry matter was insignificantly (P>0.01) affected by the treatments. Mathematical differences were observed among treatments for both sexes. The dry matter for female was higher (relatively 26.75% and 26.50 %) in T2 and T1 groups than other groups respectively. But for male (relativly 26.22% and 26.10 %) in T1 and T2 groups than other groups. For CP the higher value in female was in T1 (21.09 %) even dry matter less than T2 in T1 but the type of oil also affected on protein percentage although just mathematical differences between them and for male higher value was in T2 (20.61%) followed by T1(20.55%) . Ether extract for female higher value was in group T2 (1.73%) and lowest value was in group T1(1.06%) this is attribute for type of oil mixing, for male high value was in group T1 (1.76%) ,here due to type of sex affect on accumulated of fat. These results agree with result of **Mala *et al.* (2003).**

Total Ash for female was in group T1 (1.26%) and (1.21%) for male high value this is related with percentage of protein, these result agree with result of **Mohammed *et al.*, (2005).**

CONCLUSION

The combination of both alternatives in the diet could be of great interest in future studies. A combination of these mixing different types with different level had a greater effect than when they were used individually. We conclude that there is a possible synergistic effect between SF and USF phytochemicals in improving the performance, meat quality and cholestrol content in the meat of broilers chickens. The high protein content in the breast muscle as indicators for the quality can be obtained by the equal mixing of packed fat and sunflower oil. Also we can conclude that, there were opposite relationship between the percentage of fat on one hand and on other hand with proportion of moisture and protein.

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REFFERENCES

AHN, D. 2004. Dietary conjugated linoleic acid (CLA) Effects Lipid metabolism in Broiler chicks, Publi, Iow.Satate University Animal Industry. In *Journal of Biological Science*; 3:311-314.

BLAIR, M. – POTTER, M. – HULET, R. 1989. Effects of dietary protein and added fat on turkeys varying in strain, sex and age on Carcass characteristics. In *Journal of Poultry Science,* 68:287-296

BRUCE, E. MCDONALD, 2010; Canola Oil B Nutritional Properties, CANOLA COUNCIL OF CANADA 400-167 Lombard Avenue, Winnipeg, Manitoba, Canada R3B 0T6 • Phone: (204) 982-2100 • Fax: (204) 942-1841.email: admin@canola-council.org • www.canola-council.org.

CAREW, L. – MACHEMER, R. – SHARP, W. – FOSS, D. 1972. Fat absorption by very young chick. In *Journal of Poultry Science,* 51:738–742.

CORINO, C. –DELL'ORTO, V. –PEDRON, O. 1980. Effect of fatty acid composition of fats and oils on the nutritive efficiency of broiler feeds. In *Journal of Rivewer Zootec Veternary,* 2:94–98.

CRESPO & GARCIA1, CRESPO, N. –ESTEVE-GARCIA1, E. 2002a. Dietary polyunsaturated fatty acids decrease fat deposition in separable fat depots but not in the remainder carcass. In *Journal of Poultry Science,* 81: 512-518.

CRESPO & GARCIA1, CRESPO, N. –ESTEVE-GARCIA1, E. 2002. Dietary linseed oil produces lower abdominal fat deposition but higher de novo fatty acid synthesis in broiler chickens. In *Journal of Poultry Science*, 81: 1555-1562.

FREEMAN, C. 1984. The digestion, absorption and transport of fat - Non-ruminants.

In: J. Wiseman (Ed.), *Fats in Animal Nutrition*. Pp.105-122. London: Butterworths.

GRUNDY, S. 1986. Comparison of monounsaturated fatty acids and carbohydrates for lowering plasma cholesterol. In *Journal of New England. Medeical*, 314:745–748.

HORBANCZUK, J. – SALES, O. – PIOTROWSKI, J. – ZIEBA, G. – CELADA, T. – REKLEWSKI, T. –. KOZACYNSKI, K. 1999. Lipid, cholesterol content and fatty acid composition of ostrich eggs as influenced by subspecies. *Arch.Geflugelkd*.vol.63.1999.p.234–236.

KANG, K. – CHERIAN, G. –SIM, J. 2001. Dietary palm oil alters the lipid stability of polyunsaturated fatty acid-modified poultry products. In *Journal of Poultry Science*, vol. 80, 2001, p. 228-234.

KROLICZEWSKA, B. – JANKOWSKA, P. – ZAWADZKI, W. –OSZMIANSKI, J. 2004. Performance and selected blood parameters of broiler chickens fed diets with skullcap (Scutellaria baicalensis Georgi) root. In: *Journal of Animal and Feed Science*, vol. 13, 2004, p. 35–38. (Cited by Kroliczewska et al., 2008).

LEESON, S. – SUMMERS, J.D. 1997. *Commercial poultry nutrition*. 2nd Ed. University books, p. 214. Guelph, Ontario, Canada. ISBN 0-9695600-2-8.

MC-NAB, J. – BLAIR, J. 1988. Modified assay for true and apparent metabolizable energy based on tube feeding. In *British Journal of Poultry Sience,* 29:697–707.

MOHAMMED, H. – SARDARY, S. –MIRAN, D. 2005. The effect of utilization vegetable fat and oil of sunflower seeds and marketing age on production performance and chemical composition of broiler's carcass. Thesis, Salahaldeen University, Erbil, Iraq.

OSMAN, C. – SAID, B. – SERDAR, E. 1999, Effects of dietary oil on lipoproteins, lipid per oxidation and thromboxane A2 production in chickens.In *Turk Journal of Veternary Animal Science,* 24:473-478.

ROCHE, H. 2001. Olive oil, high-oleic acid sunflower oil and CHD. In *British Journal of Nutrition,* vol. 85, 2001, p. 3-4.

SALEH, E. –WATKINS, S. –, WALDROUP, A. –WALDROUP, P. 2003. Effects of Dietary Nutrient Density on Performance and Carcass Quality of Male Broilers Grown for Further Processing. In *International Journal of Poultry Science,* 3(1):1-10.

SKLAN, D. 1979. Digestion and absorption of lipids in chicks fed triglycerides or free fatty acids: Synthesis of monoglycerides in the intestine. In *Journal of Poultry Science,* 58:885–889.

SUCHON, T. –BOONLOM, C. – THANADEACH, M. 2007. Production of low fat and low cholesterol broiler meat by supplementing organic minerals or polyunsaturated oil .Department

of Animal Science, Faculty of Agriculture, Chiang Mai University, 50200, Thaila. The *journai of Thai phytopathotogicat society* vol 21 no1-2.

WISEMAN, J. – SALVADOR, F. 1989. Influence of age, chemical composition and rate of inclusion on the apparent metabolisable energy of fats fed to broiler chicks. . In *British Journal of Poultry Science*, 30:653–662.