

# Effects of Adding Different Proportions of Sunflower Seeds on Fatty Acid Composition of Chicken Tissues

Mawada Mahfoudh<sup>1\*</sup>, Hajer Trabelsi<sup>1</sup>, Khaled Sebei<sup>2</sup> and Sadok Boukhchina<sup>1</sup>

<sup>1</sup>Biology Department, Lipids Biochemistry Unit, Science Faculty, Tunisia

<sup>2</sup>Biology Department, Higher Institute of Applied Biological Sciences, Tunisia

## Abstract

Poultry meat becomes an essential part of our nutrition, our aim is to optimize poultry meat quality to obtain more healthy results. Because of its rich composition of desired fatty acids, we chose sunflower seeds (SS) as chicken's food to search for the best proportion to obtain the best meat composition. A basal diet is given to chickens, with proportions of 25%, 50%, and 75% of sunflower seeds, respectively for each group. The results were very adequate: the more we add SS in chicken's meal, the more its composition is expressed in chicken's tissues. So, monounsaturated fatty acids (MUFA) were the major FA, decrease for the favor of polyunsaturated fatty acids (PUFA) in all tissues, linoleic acid become the major FA taking the place of Oleic Acid. Saturated fatty acids (SFA) become, fortunately, lower; it's a target to low the content of SFA, since they have been associated with several human diseases.

**Keywords:** Fatty acids; Chickens; Sunflower seeds; Poultry meat

## Introduction

The quality of meat and animal products has become a major concern for all the poultry sector partners. The lipid content of meat, quality criterion for the consumer, depends on the nutritional characteristics of ingested food, and the quantity and quality of fat added to the diet. In recent years, there has been an increased attention towards the manipulation of the meat lipid amount and composition [1], because of animal sources, such as butter and lard, are characterised by high concentrations of saturated fatty acids. It is well known that a diet rich in saturated fatty acids forms a risk factor for hypercholesterolemia, atherosclerosis and other diseases in humans, in the other side, Many studies have shown the benefits of polyunsaturated fatty acids on human health, especially in relation to heart problems and similarly important diseases [2].

Consequently, poultry meat has become very popular thanks to its nutritional characteristics. Moreover, chicken lipids are characterized by relatively high levels of unsaturated fatty acids, which are considered as a positive and healthy aspect to consumers. So, to obtain a better meat quality, poultry meat is generally manipulated by using a selected food with particular nutritional characteristics. In fact, the ratio of unsaturated to saturated fatty acids in meat should be increased, so to achieve positive health effects [3,4]. Thus, the aim of this work is to manipulate chicken food and evaluate the effect of feeding fat sources on the quality and composition of lipids of thighs, breasts and skin of poultry meat.

As feed additive, we used Sunflower seeds in different proportions to see its impact on muscle FA deposition, in fact, Sunflower (*Helianthus annuus* L.) is one of the most widely cultivated oilseed in the world and ranks third in importance as a source of vegetable oil [5]. Most studies evaluating effects of seeds FA on poultry meat FA, were experimented by adding the oil of the seed, however, in our experiment, we added the whole seed to the animal (with the bark) and we search for better results. Even though it is an attraction for many consumers, studies on chicken's skin are very low, so, we will try to give details about it. This study provides information on the effects of processing factors on the quality characteristics of chicken's tissues (meat and skin); in economic

practice, it is important to determine how to process chicken's meat to preserve its benefits and to reduce harmful components like SFA, this will be established through special feeding to optimize poultry meat quality and to produce new poultry meat ranges, each one specialized and appointed by the food received.

## Material and Methods

### Sunflower seeds

Sunflower seed (SS) should be considered rich in energy, since it has from 3.691 to 5.004 kcal of ME.kg<sup>-1</sup> and from 19.9 to 43.4% of ether extract [5,6]. Varieties with high oil concentration have increased levels of polyunsaturated fatty acids, mainly linoleic [7], and low levels of saturated fatty acids [8].

We chose to give SS to chickens because of its characteristics; sunflower seeds are an excellent source of essential fatty acids, vitamins, minerals and energy. Sunflower kernels actually employed to extract edible oil at commercial levels. Much of their calories come from fatty acids. The seeds are especially rich in poly-unsaturated fatty acids: Linoleic acid (LA), which constitute more than 50% fatty acids in them. They are also good in mono-unsaturated: Oleic acid (OA) that helps lower LDL or "bad cholesterol" and increases HDL or "good-cholesterol" in the blood. Research studies suggest that Mediterranean diet which is rich in monounsaturated fats help to prevent coronary

\*Corresponding author: Mawada Mahfoudh, Biology Department, Lipids Biochemistry Unit, Science Faculty, 2092 El Manar 2, Tunisia, Tel: +21698988320; E-mail: [mawada.mahfoudh@yahoo.fr](mailto:mawada.mahfoudh@yahoo.fr)

Received January 22, 2016; Accepted February 12, 2016; Published February 19, 2016

Citation: Mahfoudh M, Trabelsi H, Sebei K, Boukhchina S (2016) Effects of Adding Different Proportions of Sunflower Seeds on Fatty Acid Composition of Chicken Tissues. J Food Process Technol 7: 569. doi:10.4172/2157-7110.1000569

Copyright: © 2016 Mahfoudh M, et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

artery disease, and stroke by favoring healthy blood lipid profile [9]. Fatty acid profile of SS is presented in Table 1 [10].

### Animal rearing

One hundred 1-day old broiler chicks were obtained from a commercial hatchery associated to Regional directorate of Agriculture (Nabeul, Tunisia). They are distributed in four parcels in an animal husbandry, They are placed in favorable conditions to their growth (temperature, humidity, aeration, lighting, troughs, foragers, valid nutrition according to age, vaccination, etc.). The Basal Diet (BD) is a nutritionally balanced diet given to chicks just after birth favorising a good nutrition and a healthy growth; it is composed by some proteins, vitamins, trace of minerals and different kinds of seeds. Chicks of each parcel receive a different proportion of diet (Table 2). After 42 days (the breeding period), chickens were slaughtered at a commercial abattoir (slaughterhouse) by cervical dislocation. Muscle is boneless and divided to breasts, thighs and skins separately, meat is minced using a mincing machine and preserved at -20°C.

### Extraction and analysis

Total lipids were extracted from chicken muscles using Folch et al. [11] modified by Bligh and Dyer [12], then by Allen and Good [13]. Methyl esters were prepared by transesterification using cold methanolic potassium hydroxyde solution: it's a transmethylation of the triacylglycerols according to the ISO 5509 method (1978). Fatty acid methyl esters (FAME) were analysed by a gas chromatograph.

Gas chromatography of FAME was performed with an agilent

6890N gas chromatography equipped with a flame ionization detector (FID). The operating conditions for the gas chromatograph were as follows; we began by a temprature of 75°C, increasing by 5°C/min to 148°C, from 148 to 158°C, the temperature was increased by 2.5°C/min, from 158 to 225°C per min, the temperature was increased at the rate of 5°C/min. The temperature of the injector and the detector remained stable at 280°C. The column head pressure of the conductor gas (helium) was 1.3g/cm<sup>2</sup>.

### Statistical analysis

The experimental data were analyzed using the analysis of variance (ANOVA) and the Statistical Analysis System (XLSTAT 2013) (Addinsoft USA). Differences at  $p \leq 0.05$  were considered statistically significant by Duncan's new multiple range test. All values were expressed as means  $\pm$  standard deviation of at least triplicate repetitions. Each value is a mean  $\pm$  standard deviation (SD) of a triplicate analysis performed on different samples Means with different letters were significantly different with  $p \leq 0.05$ .

## Results

### Effects on breast's fatty acids

The effects of experimental diets (SS), in its different proportions, on breast FA profile is in Table 3; Ten fatty acids(FA) were found in the analyse of FAME. Most of values Were considered statically significant by Duncan's new multiple range test. The major FA in standard breast is oleic acid, same result for chicks fed 25% SS and 50% SS, then it's reversed at 75% SS, major FA become linoleic acid, the difference is significant ( $p \leq 0.05$ ). Palmitic acid exist too with a sufficient percentage, but, it decrease significantly ( $p \leq 0.05$ ) with the consumption of SS, like all other saturated fatty acids (Myristic, stearic, arachidic, béhénic).

Breast's TFA (total fatty acids) evolution are shown in Figure 1. It shows that SFA of breast decrease with consumption of sunflower seeds whatever the proportion, their most decrease is at 75% SS and this proportion represent the top of PUFA (40.730%) and the best propotion of UFA (77.744%) values. Concerning MUFA (C16:1, C18:1, C22:1), they are concentrated in the breast of standard chickens with the highest value, same for SFA, with consumption of SS, they decrease for the favor of PUFA which are in remarkable evolution: from 24.07% to 40.73%, the highest level of UFA is in 75% SS chicks group. The polyunsaturated to saturated fatty acid ratio (P/S) is around 1.1% but it has a peak in chick's breast of 75% SS it reaches 1.828%.

### Effects on thigh's FA

Table 4 shows the effects of Sunflower Seeds on FA profile of Thigh. In first steps of minimum added diet, (standard and 25% SS) thigh's predominant FA is oleic acid; the more chicks consume SS the more oleic acid decrease, the more linoleic acid increase, so, in 50% and 75% proportions, the predominant FA becomes linoleic acid (C18:2n-6).

Fatty acids	Percentage
C16:0	5.8%
C16:1	0.1%
C18:0	3.9%
C18:1	15.9%
C18:2	71.7%
C18:3	0.6%
C18:3	0.1%
C20:0	0.3%
C20:1	0.2%
C22:0	0.7%
C24:0	0.5%

Table 1: Sunflower seeds fatty acids composition.

	Parcel 1	Parcel2	Parcel3	Parcel4
SS	25%	50%	75%	0%
BD	75%	50%	25%	100%

SS: Sunflower Seeds; 25% SS: Chicks fed 25% SS of the total diet; BD: Basal Diet ; 50% SS: Chicks fed 50% SS of the total diet; 75% SS: Chicks fed 75% of the total diet

Table 2: The ration given to each parcel.

	C14:0	C16:0	C16:1	C18:0	C18:1 (n-9)	C18:2 (n-6)	C18:3 (n-3)	C20:0	C22:0	C22:1	SFA	MUFA	PUFA	UFA	P/S
Standard(BD)	0.460 <sup>c</sup>	21.880 <sup>d</sup>	4.860 <sup>d</sup>	6.385 <sup>b</sup>	39.940 <sup>c</sup>	24.070 <sup>a</sup>	0.000 <sup>a</sup>	1.845 <sup>c</sup>	0.180 <sup>b</sup>	0.380 <sup>b</sup>	30.750	45.180	24.070	69.250	1.124
25% SS	0.440 <sup>bc</sup>	17.785 <sup>b</sup>	2.370 <sup>b</sup>	7.140 <sup>d</sup>	38.180 <sup>bc</sup>	30.925 <sup>b</sup>	0.570 <sup>d</sup>	2.000 <sup>d</sup>	0.150 <sup>b</sup>	0.440 <sup>c</sup>	27.515	40.989	31.495	72.483	1.144
50% SS	0.410 <sup>b</sup>	19.380 <sup>c</sup>	4.060 <sup>c</sup>	7.140 <sup>d</sup>	36.935 <sup>a</sup>	31.860 <sup>b</sup>	0.190 <sup>b</sup>	1.490 <sup>b</sup>	0.075 <sup>a</sup>	0.320 <sup>a</sup>	28.495	41.313	32.050	73.363	1.124
75% SS	0.235 <sup>a</sup>	14.220 <sup>a</sup>	1.575 <sup>a</sup>	6.575 <sup>c</sup>	35.075 <sup>a</sup>	40.365 <sup>c</sup>	0.365 <sup>c</sup>	1.045 <sup>a</sup>	0.200 <sup>b</sup>	0.365 <sup>b</sup>	22.275	37.014	40.730	77.744	1.828

Values are mean  $\pm$  SD. Values that are followed by different letters within each row are significantly different ( $p \leq 0.05$ )

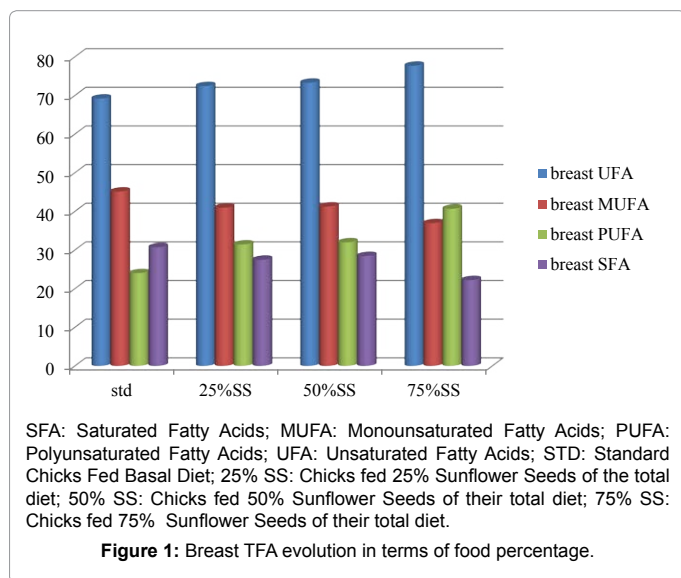
SFA: Saturated Fatty Acids; MUFA: Monounsaturated Fatty Acids; PUFA: Polyunsaturated Fatty Acids; UFA: Unsaturated Fatty Acids; P/S: Polyunsaturated to Saturated Fatty Acids Ratio; STD: Standard Chicks Fed Basal Diet; 25% SS: Chicks fed 25% Sunflower Seeds of the total diet; 50% SS: Chicks fed 50% Sunflower Seeds of their total diet; 75% SS: Chicks fed 75% Sunflower Seeds of their total diet.

Table 3. Fatty acids profile of chicken's breast.

The effect of treatments on concentration of FA (C14:0, C16:0, C16:1, C18:0, C18:1, C18:2) was noticeable ( $p \leq 0.05$ ). TFA evolution is shown in Figure 2. Thigh's SFA decrease with the consumption of SS; it begins by 32.695% for standard ration and decreases proportionally with the increase of SS proportion, it becomes 21.715% for 75% SS. The same experience showed a significant effect on MUFA in thigh, it decreases proportionally with consumption of SS. While, PUFA grow increasingly with consumption of Sunflower seeds and reaches 46.685% at 75% of SS of total alimentation, so, UFA develop too with the uptake of Sunflower seeds.

### Effects on skin's FA

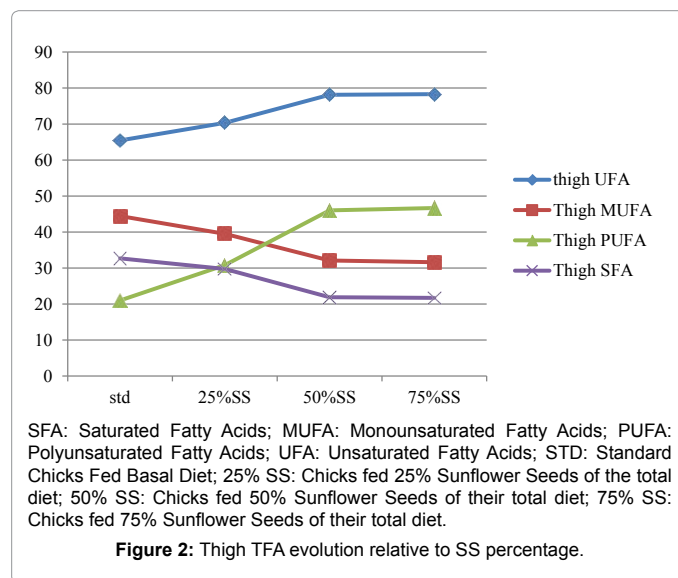
Skin tissue is also analysed. It was affected by Sunflower seeds nourishment. The results has been shown in Table 5. Even for Skin, the same results are found; oleic acid, is the major FA for standard group and it stays the same in 25% SS group, then it's reversed in 50% SS and 75% SS ration to the linoleic acid. SFA and MUFA decrease with the SS uptake to the favor of PUFA in fat tissue too (Figure 3).



### Discussion

The breast's major FA is oleic acid at 25% and 50% SS. Our major FA is reversed at 75% SS, it becomes linoleic acid with a very important percentage (40.365%). Crespo and Esteve Garcia [14] proved that Birds fed sunflower oil showed higher values of linoleic acid (c18:2 n-6) than those fed tallow, olive, or linseed oil. Oleic acid was the second FA (since 75% SS) like in SSFA (sunflower seeds FattyAcids) (Table 2) and in chicken's meat FA: Table 2, showing SSFA composition, demonstrate that this composition is reflected on FA profile of chicken's meat. The major FA (linoleic acid(LA)) of SS (71%) influenced LA in chicken tissue, it becomes 40%. However it beomes the second FA (at 75% SS), oleic acid have anyway an important value staying relatively high and beneficial.

MUFA and SFA are concentrated in the breast and thigh of standard chicken with high percentages, they decrease for the favor of PUFA. Similar trends are reported by Grau et al. [15] who determined



	C14:0	C16:0	C16:1	C18:0	C18:1 (n-9)	C18:2 (n-6)	C18:3 (n-3)	C20:0	C22:0	C22:1	SFA	MUFA	PUFA	UFA	P/S
Standard(BD)	0.570 <sup>c</sup>	23.645 <sup>c</sup>	4.995 <sup>c</sup>	6.620 <sup>b</sup>	39.125 <sup>c</sup>	20.850 <sup>a</sup>	0.155 <sup>a</sup>	1.725 <sup>a</sup>	0.135 <sup>a</sup>	0.320 <sup>a</sup>	32.695	44.440	21.005	65.445	0.642
25% SS	0.430 <sup>b</sup>	20.025 <sup>b</sup>	3.130 <sup>a</sup>	7.340 <sup>c</sup>	36.080 <sup>b</sup>	30.625 <sup>b</sup>	0.190 <sup>a</sup>	1.815 <sup>a</sup>	0.125 <sup>a</sup>	0.295 <sup>a</sup>	29.735	39.505	30.815	70.320	1.036
50% SS	0.285 <sup>a</sup>	13.770 <sup>a</sup>	1.900 <sup>a</sup>	6.325 <sup>a</sup>	29.860 <sup>a</sup>	45.880 <sup>c</sup>	0.140 <sup>a</sup>	1.335 <sup>a</sup>	0.165 <sup>a</sup>	0.335 <sup>a</sup>	21.880	32.095	46.020	78.115	2.100
75% SS	0.325 <sup>a</sup>	13.860 <sup>a</sup>	2.060 <sup>a</sup>	6.470 <sup>ab</sup>	29.230 <sup>a</sup>	46.505 <sup>c</sup>	0.180 <sup>a</sup>	0.920 <sup>a</sup>	0.140 <sup>a</sup>	0.325 <sup>a</sup>	21.715	31.615	46.685	78.300	2.149

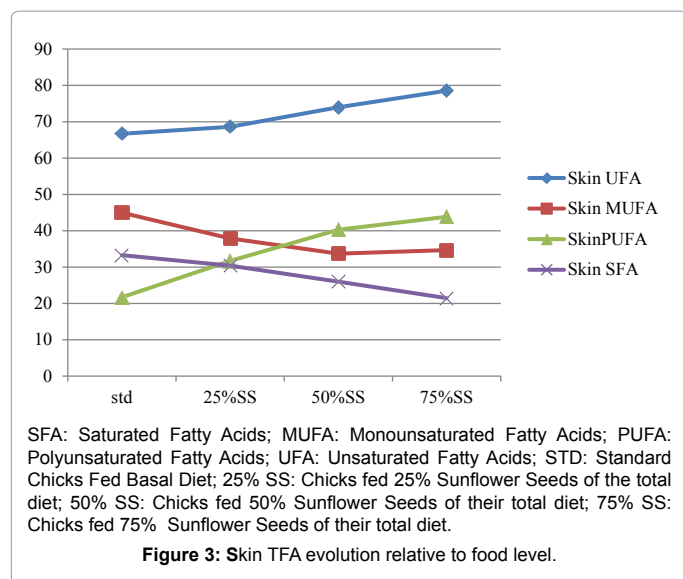
Values are mean  $\pm$  SD. Values that are followed by different letters within each row are significantly different ( $p \leq 0.05$ )  
 SFA: Saturated Fatty Acids; MUFA: Monounsaturated Fatty Acids; PUFA: Polyunsaturated Fatty Acids; UFA: Unsaturated Fatty Acids; P/S: Polyunsaturated to Saturated Fatty Acids Ratio; STD: Standard Chicks Fed Basal Diet; 25% SS: Chicks fed 25% Sunflower Seeds of the total diet; 50% SS: Chicks fed 50% Sunflower Seeds of their total diet; 75% SS: Chicks fed 75% Sunflower Seeds of their total diet.

**Table 4: Fatty acids profile of thigh meat.**

	C14:0	C16:0	C16:1	C18:0	C18:1 (n-9)	C18:2 (n-6)	C18:3 (n-3)	C20:0	C22:0	C22:1	SFA	MUFA	PUFA	UFA	P/S
Standard (BD)	0.460 <sup>b</sup>	23.060 <sup>d</sup>	5.110 <sup>d</sup>	7.360 <sup>c</sup>	39.730 <sup>c</sup>	21.715 <sup>a</sup>	0.000 <sup>a</sup>	2.295 <sup>c</sup>	0.120 <sup>c</sup>	0.150 <sup>a</sup>	33.295	44.990	21.715	66.705	0.652
25% SS	0.455 <sup>b</sup>	20.475 <sup>c</sup>	2.630 <sup>c</sup>	8.250 <sup>d</sup>	35.165 <sup>b</sup>	31.590 <sup>b</sup>	0.120 <sup>b</sup>	1.210 <sup>b</sup>	0.000 <sup>a</sup>	0.110 <sup>a</sup>	30.390	37.905	31.710	68.615	1.043
50% SS	0.310 <sup>a</sup>	15.365 <sup>b</sup>	1.990 <sup>a</sup>	7.140 <sup>b</sup>	31.290 <sup>a</sup>	40.105 <sup>c</sup>	0.180 <sup>c</sup>	3.090 <sup>d</sup>	0.100 <sup>bc</sup>	0.430 <sup>b</sup>	26.005	33.710	40.285	73.995	1.549
75% SS	0.365 <sup>a</sup>	14.720 <sup>a</sup>	2.230 <sup>b</sup>	5.675 <sup>a</sup>	32.330 <sup>a</sup>	43.510 <sup>d</sup>	0.325 <sup>d</sup>	0.645 <sup>a</sup>	0.070 <sup>b</sup>	0.130 <sup>a</sup>	21.475	33.710	43.835	78.525	2.041

Values are mean  $\pm$  SD. Values that are followed by different letters within each row are significantly different ( $p \leq 0.05$ )  
 SFA: Saturated Fatty Acids; MUFA: Monounsaturated Fatty Acids; PUFA: Polyunsaturated Fatty Acids; UFA: Unsaturated Fatty Acids; P/S: Polyunsaturated to Saturated Fatty Acids Ratio; STD: Standard Chicks Fed Basal Diet; 25% SS: Chicks fed 25% Sunflower Seeds of the total diet; 50% SS: Chicks fed 50% Sunflower Seeds of their total diet; 75% SS: Chicks fed 75% Sunflower Seeds of their total diet.

**Table 5: Fatty acids profile of skin.**



that raw meat from chickens fed with beef tallow had 34.41% SFA, 47.29% MUFA, and 18.34% PUFA, whereas those fed with sunflower oil showed 22.62% SFA, 34.96% MUFA, and 42.47% PUFA [16].

As regards to the skin, like the thigh and breast, skin's linoleic acid grow up proportionally with the consumption of sunflower seeds. Viveros et al. [17] also, showed significant differences in the fatty acid concentrations of abdominal fat among dietary fat sources. The contents of the major fatty acids, palmitic acid (C16:0), stearic acid (C18:0), oleic acid (C18:1n-9), and linoleic acid (C18:2n-6) in abdominal fat reflected the fatty acid profile of the dietary fat. The C18:2n-6 content was significantly greater in Conventional SS diets. The PUFA/MUFA and UFA/SFA ratios were significantly increased (up to 44%). In our experiment, diet's FA are well expressed in fat tissue, even like muscle tissue. Maria et al. [18] showed that it should be stressed that dietary fatty acid composition is best represented by fat tissue rather than muscle tissue. The results of Ortiz et al. [19], showed too a more efficient modification of adipose than intramuscular fat profile, which was probably due to the physiological lipid storage function of adipose tissue.

To synthesize, SFA and MUFA decreases for the favor of PUFA in all tissues (Figures 1-3). Consequently, P/S ratio increase from 0.642% for standard group to 2.149% for 75% SS group. Likewise Ortiz et al. [19] found too that when we feed chickens with a source of fat in C18:1n-9 (HOASS (high oleic acid sunflower seeds) or its oil), or C18:2n-6 (CSS (conventional sunflower seeds) or its oil), the proportion of MUFA and PUFA, respectively, increased in abdominal fat as well as in breast and thigh muscles. The proportionality is detected too in the experience of Lopez-Ferrer et al. [20] who used different percentages of flaxseed oil in diets for chicken and obtained different values of Linolenic acid in chicken meat. Increasing the flaxseed oil decreased the SFA and MUFA and increased the PUFA [13]. Breast, thigh and Skin, are affected by food quantity and quality, indeed, the amount added to the diet has changed the quantity (in%) of meat and fat tissue FA, and the quality of FA of the seeds (FASS) is reproduced on the quality of meat FA, and fat tissues.

Comparing breast's and thigh's and skin's FA, we note that thigh and skin are more sensitive to dietary FA than breast; their FA composition is changed and their major FA becomes Linoleic Acid

from 50% SS ration (Breast at 75% SS). In 25% SS ration, results are not well expressed in all tissues, this could be explained by the lower level of fat added, as it has been stated, the dietary fatty acids incorporated into the muscular tissues will be relatively more diluted by de novo synthesized fatty acids at low fat intakes than at high fat intakes, Ortiz et al. [19] and Hardinka et al. [21] Confirm this. It appears that the increased PUFA with proportional decrease of MUFA and SFA are related phenomena, in fact, the concentration of PUFA is resulted from direct deposition of diet fat [22], it is assumed that MUFA and SFA give way to PUFA and degrade in liver, in this direction, Cortinas et al. [23] Showed that with increase in concentration of PUFA in diet, concentration of MUFA decreases in tissue, these results were also obtained by schreiner et al. [24], and Dobrzanski et al. [25].

Chicks fed sunflower oil showed higher values of linoleic acid (c18:2 n-6), linoleic acid replaced myristic, palmitic, stearic and oleic acids in all tissues [14]. This suggest the same hypothesis that these FA are leaving tissues letting place to other FA derived from diet (essentially PUFA by direct deposition). Where as, Lopez-Ferrer et al. [26] reported that the concentration of SFA and MUFA in tissue have completely dependence on contents of diet. They maintained that this may be dependent on relation between conversion in liver, deposition on tissue and turnover from carbohydrates. Normally in poultry, de novo lipogenesis occurs in the liver from dietary carbohydrates, reactions catalyzed by both: glucose-6-phosphate dehydrogenase and malic enzyme that provide the reduced equivalents required for de novo synthesis. Subsequently, triglycerides are hydrolyzed into glycerol and fatty acids and transported to adipose tissue in chylomicrons and very low density lipoprotein [27] deposited in the fatty organ or oxidized to obtain energy [28-30]. In fact, Doreau and Chilliard [31], show that In birds, the effects of adding dietary fats on adipose tissue metabolism are secondary to changes in lipid metabolism in the liver (the main site of FA synthesis in these species). The reduction of dietary carbohydrates when fat is supplied in the diet decreases the de novo synthesis of FA [32] and VLDL secretion by the liver. The proportion of dietary FA in circulating lipids then increases, so that body fat mainly depends on the direct uptake of exogenous FA. Due to the reduction of de novo FA synthesis, body fat deposition mainly depends on the direct uptake of preformed FA. For this reason, FA composition of body lipids is highly correlated to the nature of FA intake. For example, the proportion of linolenic acid in body fat of chickens fed with linseed oil can reach 34 g/100g instead of 1 g/100g with classical diets [33]. In broilers, lipid classes are unevenly distributed in different tissues; triacylglycerols, the most abundant, and the most affected by food, polar lipids were little affected, triacylglycerols carry with them, so, the dietary lipids to different muscle tissues [19,20]. Since the recommended low value of n-6/n-3 ratio, and knowing that chicken's meat is not a source of n-3 FA, the proportion of 75% which has incurred a remarkable transformation and a great increase in n-6 FA, could be discouraged because of the high level of n-6/n-3 ratio (high value of n-6) which can be noxious on the oxidative situation; But we could contradict this hypothesis as our added diet is an excellent source of vitamin E [34], the body's primary fat-soluble antioxidant, it plays an important role in the prevention of cardiovascular disease. It is one of the main antioxidants found in cholesterol particles and helps prevent free radicals from oxidizing cholesterol. Vitamin E has significant anti-inflammatory effects that result in the reduction of symptoms in asthma, osteoarthritis, and rheumatoid arthritis, conditions where free radicals and inflammation play a big role. Vitamin E has also been shown to reduce the risk of colon cancer, help decrease the severity and frequency of hot flashes in women going through menopause, and help reduce the development



of diabetic complications [34]. All these benefits of SS are reproduced in chickens and will help to defend against drawbacks of n-6/n-3 (if any). The best proportion in our work could be 50% SS since both FA, Linoleic acid and Oleic Acid are very narrow range giving the desired nutritional balance. A remarkable difference between n-3 and n-6 FA in our experiment, this distribution is not aleatory, the highest values of n-6 fatty acids were found in thighs and breasts of birds fed sunflower seeds, possibly due to the competition for  $\Delta$ -5 and  $\Delta$ -6 desaturase between n-3 and n-6 fatty acids in these tissues. For the same reason, the lowest values of n-3 derivatives were found in muscles of birds fed sunflower. These results are in accordance with Crespo and Esteve-Garcia [14]. Differences in tissue fatty acid profiles could be attributed to different roles of fatty acids in these tissues or to their different contents of phospholipids. PUFA are preferentially incorporated into phospholipids [35] and phospholipids are in higher proportion in muscle fat than in adipose tissue fat [36], which could explain different compositions of fat in different tissues.

So, As already reported in literature [37-42] the fat sources used as integration for diets can effectively affect the fatty acid composition of monogastric's lipid tissues [16]. Marion and Woodroof [43] too, found that the fatty acid composition in broiler tissues was easily influenced by dietary lipids.

## Conclusion

Adding the whole seed to chicken's diet proved that it is easier and gives significant results. The addition of SS in the poultry diet cause an increase in n-6 FA of their meat. LA is the major FA, but oleic acid is the second one and its values stay relatively high and beneficial (about 30%). The wealth of meat by UFA, SFA, (n-6) FA, P/S ratio are proportional to consumption of sunflower seeds by chickens. Thigh is more sensitive to dietary FA than breast, it acquires the effects of SS from 50% SS (Breast at 75% SS); the difference is related to richness of each muscle by phospholipids and triacylglycerols essentially, since total fatty acid intake is the same (the same chicken). FA composition of body lipids is highly correlated to the nature of FA intake, and the concentration of PUFA is resulted from direct deposition of diet fat. Poultry meat, a low-fat meat compared with red meat, and rich by PUFA (in our case), is usually recommended by dieticians, but, Some researchers find the large amount of n-6 discouraged, although, in our experience we can say that it is beneficial due to its origin from SS, source of vitamin E, a luxury antioxidant. So, it is concluded that the seeds of conventional varieties of sunflower might be used in poultry feeding in order to increase PUFA contents in both abdominal adipose tissue and intramuscular fat. Adding proportions in ascending order of SS to the parcels, proves that a proportionality is established in the quality and quantity of FA; This will have a great importance in poultry economy by producing types of chicken's meat according to all tastes and needs of consumers; So, we can manipulate chicken meat as we want by adding the food that suits with our needs, it will be reproduced in the meat; we could process by the same technical way to produce: n-3 chickens, n-6 chickens (our study), O.A chickens, SFA chickens, etc. to meet urban demand.

## References

1. Wood JD, Richardson RI, Nute GR, Fisher AV, Campo MM, et al. (2004) Effects of fatty acids on meat quality: a review. *Meat Sci* 66: 21-32.
2. Leskanich CO, Noble RC (1997) Manipulation of the n-3 polyunsaturated fatty acid composition of avian eggs and meat. *World's Poultry Science Journal* 53: 155-183.
3. Reddy BS (1995) Nutritional factors and colon cancer. *Crit Rev Food Sci Nutr* 35: 175-190.
4. Søyland E, Drevon CA (1993) The effect of very long-chain n-3 fatty acids on immune-related skin diseases. *Eur J Clin Nutr* 47: 381-388.
5. Ortiz LT, Alzueta C, Rebolé A, Rodríguez ML, Arija I, et al. (2006) Effect of dietary high oleic acid and conventional sunflower seeds and their refined oils on fatty acid composition of adipose tissue and meat in broiler chickens. *Journal of animal and feed sciences*. 15: 83-95.
6. Cheva IB, Tangaweewipat S (1990) Effect of different levels of sunflower seed in broiler rations. *Poultry Science* 70: 2284-2294.
7. Senkoylu N, Dale N (1999) Sunflower meal in poultry diets: a review. *World's Poultry Science Journal*. 55: 153-174.
8. Pelegrini B, Girassol (1989) Uma planta solar que da América conquistou o mundo. São Paulo, Icone.
9. Umesh R (2015) Sunflower seeds nutrition facts.
10. Esoteric Oils CC, Sallamander Concepts (2010) The world of pure essential oils.
11. Folch J, Lees M, Sloan SGH (1957) A simple method for the isolation and purification of total lipids from animal tissues. *Journal of Biological Chemistry* 226: 497-509.
12. Bligh EG, Dyer WJ (1959) A rapid method for total lipid extraction and purification. *Can J Biochem Physiol* 37: 911-917.
13. Allen CF, Good P (1971) Acyl lipids in photosynthetic systems. *Methods enzymol* 13: 523-547.
14. Crespo N, Esteve-Garcia E (2001) Dietary fatty acid profile modifies abdominal fat deposition in broiler chickens. *Poult Sci* 80: 71-78.
15. Grau A, Codony R, Grimpa S, Baucells MD, Guardiola F, et al. (2001) Cholesterol oxidation in frozen dark chicken meat: influence of dietary fat source, and  $\alpha$ -tocopherol and ascorbic acid supplementation. *Meat Sci* 57: 197-208.
16. Matteo B, Maria FC, Maria TR, Giovanni L (2006) Effect of feeding fat sources on the quality and composition of lipids of precooked ready-to-eat fried chicken patties. *Food Chemistry* 10: 1327-1337.
17. Viveros A, Ortiz LT, Rodríguez ML, Rebolé A, Alzueta C, et al. (2009) Interaction of dietary high-oleic-acid sunflower hulls and different fat sources in broiler chickens. *Poult Sci* 88: 141-151.
18. Maria CM, Roseli GP, Carmino H, Nilson ES, Makoto M, et al. (2003) Influence of diets enriched with different vegetable oils on the fatty acid profiles of snail *Helix aspersa maxima*. *Food Chemistry* 82: 553-558.
19. Rodríguez ML, Ortiz LT, Alzueta C, Rebolé A, Treviño J, et al. (2005) Nutritive value of high-oleic acid sunflower seed for broiler chickens. *Poult Sci* 84: 395-402.
20. Sanz M, Carmona JM, Lopez-Bote CJ (2002) Quantitative effect of dietary fatty acids on fatty acid composition and fat firmness in broilers. *Arch Geflügelk* 66: 211-215.
21. Hardinka C, Zollitsch W, Knaus W, Lettner F (1996) Effects of dietary fatty acid pattern on melting point and composition of adipose tissues and intramuscular fat of broiler carcasses. *Poult Sci* 75: 208-215.
22. Ali AS, Hossein I, Mohammad KT, Mohammad C (2012) Fatty Acids Profiles in Meat of Broiler Chicks Fed Diet Containing Corn Oil Switched to Fish Oil at Different Weeks of Age. *World Applied Sciences Journal* 18: 159-165.
23. Cortinas L, Villaverde C, Galobart J, Baucells MD, Codony R, et al. (2004) Fatty acid content in chicken thigh and breast as affected by dietary polyunsaturation level. *Poult Sci* 83: 1155-1164.
24. Schreiner M, Hulan HW, Razzazi-Fazeli E, Bohm J, Moreira R, et al. (2005) Effect of different source of dietary omega-3 fatty acid on general performance and fatty acid profiles of thigh, breast, liver and portal blood of broilers. *J Sci Food Agric* 85: 216-226.
25. Dobrzański Z, Jamroz D, Bykowski P, Trziszka T (2002) Effect of fish oil on broiler performance and meat quality, *Electronic Journal of Polish Agriculture Universities* 1: 43-51.
26. López-Ferrer S, Baucells MD, Barroeta AC, Galobart J, Grashorn MA, et al. (2001) n-3 enrichment of chicken meat. Use of precursors of long-chain polyunsaturated fatty acids: linseed oil. *Poult Sci* 80: 753-761.
27. Mourof J, Hermier D (2001) Lipids in monogastric animal meat. *Reprod Nutr Dev* 41: 109-118.
28. Ferrini G, Manzanilla EG, Menoyo D, Esteve GE, Baucells MD, et al. (2010)

- Effects of dietary n-3 fatty acids in fat metabolism and thyroid hormone levels when compared to dietary saturated fatty acids in chickens. *Livest Sci* 131: 287-291.
29. Žlender B, Antonija H, Vekoslava S, Polak T (2000) Fatty acid composition of poultry meat from free range rearing. *Poljopriverda* 6: 53-56.
30. Alvarez MJ, Díez A, López-Bote C, Gallego M, Bautista JM, et al. (2000) Short-term modulation of lipogenesis by macronutrients in rainbow trout (*Oncorhynchus mykiss*) hepatocytes. *Br J Nutr* 84: 619-628.
31. Doreau M, Chilliard Y (1997) Digestion and metabolism of dietary fat in farm animals. *Br J Nutr* 78 Suppl 1: 15-35.
32. Hillard BL, Lundin P, Clarke SD (1980) Essentiality of dietary carbohydrate for maintenance of liver lipogenesis in the chick. *J Nutr* 110: 1533-1542.
33. Edwards HM, Hart P (1971) Carcass composition of chickens fed carbohydrate-free diets containing various lipid energy sources. *J Nutr* 101: 989-996.
34. The George Mateljan Foundation (2015) The world's healthiest foods.
35. Whitehead CC, Armstrong J, Herron KM (1990) The growth to maturity of lean and fat lines of broiler chickens given diets of different protein content: body composition, plasma lipoprotein concentration and initial egg production. *Anim Prod* 50: 183-190.
36. Enser M, Wiseman J (1984) The chemistry, biochemistry and nutritional importance of animal fats. *Fats in Animal Nutrition*, London, UK.
37. Dagher NJ, Raz MA, Uwayjan M (1980) Studies the utilization of full fat sunflower seed in broiler rations. *Poultry Science* 59: 2273-2278.
38. Bou R, Guardiola F, Grau A, Grimpa S, Manich A, et al. (2001) Influence of dietary fat source, alpha-tocopherol, and ascorbic acid supplementation on sensory quality of dark chicken meat. *Poult Sci* 80: 800-807.
39. Gray JI, Crackel RL, Ledward DA, Johnston DE (1992) Oxidative flavour changes in meats: their origin and prevention. *The chemistry of muscle-based foods*. The Royal Society of Chemistry, Cambridge, UK.
40. Lin CF, Gray JI, Asghar A, Buckley DJ, Booren AM, et al. (1989) Effects of dietary oils and a-tocopherol supplementation on lipid composition and stability of broiler meat. *J Food Sci* 54: 1457-1460.
41. Gallardo MA, Pérez DD, Leighton FM (2012) Modification of fatty acid composition in broiler chickens fed canola oil. *Biol Res* 45: 149-161.
42. O'Neill LM, Galvin K, Morrissey PA, Buckley DJ (1998) Comparison of effects of dietary olive oil, tallow and vitamin E on the quality of broiler meat and meat products. *Br Poult Sci* 39: 365-371.
43. Marion JE, Woodroof JG (1963) The fatty acid composition of breast, thigh and skin tissues of chicken broilers as influenced by dietary fats. *Poultry Sci* 42: 1202-1207.