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A Challenge for Industry—to Transform Chicken Skin into Leather to Benefit Food Safety and Human Health

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A Challenge for Industry—to Transform Chicken Skin into Leather to Benefit Food Safety and Human Health

Abstract
High cholesterol, obesity and cardiovascular diseases tend to accompany the economic development of a country. This occurs not only from increased supply of fatty foods, but also from ignorance and use of poor diets. It is known that the dietary habits of the different populations reflect a historical process of adaptation to the regional realities. Chicken skin is rich in cholesterol and the emergence of this in the blood depends on the composition of the diet, and increased consumption by the Brazilian population has been noted in the last few decades concurrently with increased poultry consumption. It is also known that the population consumes fried skin, which further impacts health. To restrict the use of the skin maybe through legislation was the best solution, but it would affect the productivity of the poultry sector negatively. In Brazil, per capita poultry consumption passed from 4 to 23 kg/year. A study was developed to reduce consumption of chicken skin while maintaining or enhancing poultry profitability by converting skin into treated leather. The collected data allowed inference of the economical viability and consumer benefits. The first stage of this work was the study of the economical variability and the skin transformation in treated leather. A second phase is planned to obtain representative analyses of skin nutritional content (cholesterol, fatty acids and triglycerides), to further quantify fats composition prior to cooking.

Keywords
Chicken skin, Food Safety, Cholesterol, Nutrition, Natural Products

Disciplines
Bioresource and Agricultural Engineering

Comments
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A Challenge for Industry – to Transform Chicken Skin into Leather to Benefit Food Safety and Human Health

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Summary: High cholesterol, obesity and cardiovascular diseases tend to accompany the economic development of a country. This occurs not only from increased supply of fatty foods, but also from ignorance and use of poor diets. It is known that the dietary habits of the different populations reflect a historical process of adaptation to the regional realities. Chicken skin is rich in cholesterol and the emergence of this in the blood depends on the composition of the diet, and increased consumption by the Brazilian population has been noted in the last few decades concurrently with increased poultry consumption. It is also known that the population consumes fried skin, which further impacts health. To restrict the use of the skin maybe through legislation was the best solution, but it would affect the productivity of the poultry sector negatively. In Brazil, per capita poultry consumption passed from 4 to 23 kg/year. A study was developed to reduce consumption of chicken skin while maintaining or enhancing poultry profitability by converting skin into treated leather. The collected data allowed inference of the economical viability and consumer benefits. The first stage of this work was the study of the economical variability and the skin transformation in treated leather. A second phase is planned to obtain representative analyses of skin nutritional content (cholesterol, fatty acids and triglycerides), to further quantify fats composition prior to cooking.

Keywords. Chicken skin, Food Safety, Cholesterol, Nutrition, Natural Products
INTRODUCTION

The systems of animal production have been marked by the words productivity, profit, production, and this has prevented to think of animal production in a less industrial and more humane way, turning back to its real purpose, which is the human food consumption. The process of raising animals requires therefore being environmentally beneficial, ethically defensible, socially acceptable and important to the objectives, needs and resources of the community for which it was designed to serve.

Data on the production sectors worldwide showed that all populations, with no exception, increased their chicken consumption in the last decades (Table 1). In Brazil, in the last 10 years, per capita consumption raised from 14.7 to 32 kg year\(^{-1}\). This is justified by the launch in the market of a protein source considered healthy from the dietary and nutritional point of view, not to mention its lower cost. Therefore, it has been considered the agricultural activity of greater development. Of the total production estimated for Brazil, in 2002, 5.8 million tons of chickens or 10% of skin, which if not consumed or treated represent an enormous annual economical loss, about U$2,457 billion dollars. On the other hand, a great part of the chronic diseases arises from bad dietary habits as a principal risk factor. Here, one can refer to the use of fried chicken skin that is very rich in cholesterol and its contribution to the onset of hypercholesterolemia. A chicken has 160-180g of skin on average, which is the part with the largest cholesterol and saturated fat contents. When skin is prepared for consumption, its contents of saturated and unsaturated fatty acids increases still more, as well as total cholesterol and fractions.

Table 1 – Poultry Production (10\(^9\) kg) and Consumption in Brazil and Worldwide, 1990-2000.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>World production</td>
<td>24,427</td>
<td>36,900</td>
<td>37,818</td>
<td>40,628</td>
</tr>
<tr>
<td>Brazilian production</td>
<td>2,356</td>
<td>4,455</td>
<td>4,498</td>
<td>5,850</td>
</tr>
<tr>
<td>World export</td>
<td>2,177</td>
<td>4,790</td>
<td>4,706</td>
<td>6,721</td>
</tr>
<tr>
<td>Brazilian export</td>
<td>0,299</td>
<td>0,649</td>
<td>0,612</td>
<td>0,771</td>
</tr>
<tr>
<td>World import</td>
<td>1,653</td>
<td>4,005</td>
<td>3,620</td>
<td>5,546</td>
</tr>
<tr>
<td>World consumption</td>
<td>23,980</td>
<td>35,741</td>
<td>36,312</td>
<td>39,593</td>
</tr>
<tr>
<td>Brazilian consumption</td>
<td>2,057</td>
<td>3,806</td>
<td>3,886</td>
<td>4,755</td>
</tr>
<tr>
<td>Per capita consumption - Brazil (kg inhabitant(^{-1}) year(^{-1}))</td>
<td>14.7</td>
<td>24.0</td>
<td>26.3</td>
<td>32.1</td>
</tr>
</tbody>
</table>

Simply removing chicken skin that would otherwise be consumed is one way of solving the problem, but then two possibilities of losses arise, ending up in serious
conflicts. On one hand for the producers (180g of each sold chicken) and on the other hand for consumers (180g of each bought chicken), in spite of knowing that the final prices would be bound to be passed on to the consumer.

In order to solve this dilemma, it has been thought about giving another use to the skin, removing it from human diet and giving it another destination: an industrial processing - leather. An analysis of the economical viability of its possible uses by the industry in several sectors, such as footwear, clothing, etc was carried out. Following the analysis, the first step towards the work was initiated. The objective was to transform skin into a by-product with larger use and profitability for the production sector, without missing the thinking of a humanitarian production, to limit or minimize hypercholesterolemia (by removing the skin from the market before offering it to human consume). It is still necessary to raise funds, however some assays have already been initiated and some partial results have been collected.

It is strongly believed that consumer education is a fundamental necessity for any population, and that dietary education is critical in developing markets. The rights of a people to a healthy diet, to an ecologically balanced food production system, and sensitivity to one’s cultural environment, are necessary ingredients for the continual improvement of the quality of life. Hypocrites once said about this: "The wise man should consider that health is the greatest of human blessings. One of the first things to do in order to play an active role in one’s own health is to insure that he is getting a proper nutrition."

MATERIALS AND METHODS

Treated skin - leather. The standard process of treatment has been to used skimming with acetate in soxler flasks, cleaning with vegetable tannin, treatment with taxidermist’s antifungal soap, drying and softening. Through a specific method of preservation, the technique of a taxidermist’s soap appropriate to treating chicken skin was improved (Tinôco, 1995; patent applied for). In another laboratory phase, the physical characteristics of the treated skin will be assayed (tests of permeability, elasticity, resistance, and texture).

Economical analysis of skin and diseases. For skin weight determination a precision electronic weigh scale was used in 3 groups of 30 birds, by size: small (1.7 kg), medium (2 kg) and large (> 2 kg). Following weighing, group averages were evaluated to determine size and costs.

Data on chicken production and consumption in Brazil and in the World between 1990 and 2000 were collected (Table 1). Human population morbidity rates were related to the Index of Corporal Mass (IMC) of 180 individuals who consume chicken one to three times a week (Lwanga, 1982).

Analysis of biochemical components. Fat analyzer TECNAL and ALISAR measured fat contents and total cholesterol, from breast meat of 8 groups of 5-chickens (a total of 40 chickens, 1.7 – 2 kg). Each group was prepared by different methods with and without skin: raw, boiled, fried and grilled. Following total extraction, fat was weighed and stored for subsequent biochemical analysis (centesimal composition) using techniques such as: gas chromatography and spectrophotometer, visible UV for
cholesterol and triglycerides analyses, according to Christie (1987) and Lima (1985). In future, mineral analyses will be carried out by using techniques such as atomic absorption and fire photometry, according to Jeffery (1981). Proteins will be quantified by spectrophotometer and HPLC, according to Bradford (1976) and Hugli (1989). Carbohydrates will be dosed by spectrophotometer according to Teles (1979) and vitamins through HPLC according to Krstulovic (1982).

RESULTS AND DISCUSSION

A chicken has 160-180g of skin on average, presenting on average, saturated fat rate of 1900 mg/100g and cholesterol 300mg /100g (Figure 1).

It is worth noticing in Figure 1 the relation between total cholesterol and saturated fat - it was noticed that the heavier the chicken the larger the amount of saturated fat. However, the same cannot be said about total cholesterol and fractions, which needs evaluation to verify if in fact these relations exist. It is known, however, that cholesterol is a lipid, of the class of steroids, and it combines with the fatty acids, forming cholesterol esters. Cholesterol is soluble in fat, producing a doughy substance and virtually all the food of animal origin contains it in solution (Figure 1). Although the liver synthesizes most of that cholesterol, the amount that appears in the blood is influenced by the diet composition, usually with high fat level.

Because the scientific community is concerned with the increase of hypercholesterolemia the Second Brazilian Consent of Cardiology on dislipidemie: detection, evaluation and treatment, in 1996, recommended that all adults above 20 years old had their lipid profile determined. Figure 2 shows some partial results of a work being developed in Viçosa, MG, Brazil. Rates of total cholesterol, triglycerols, LDL cholesterol and HDL cholesterol have been evaluated as it is known that personal health is influenced by the consumption of unhealthy food. Figure 2 also shows this discussion. It is known that dietary habits result from the answer of the individual or group to culture and social pressures on the selection, consumption and use of parts of the available food resources. The fact is that a number of researchers have been observing consumers' concerns in relation to the risks for health associated to food consumption. Chicken skin is greatly consumed in many Brazilian regions, fried or other forms of preparations, and its social meaning has to be studied and evaluated, after all it is rich in cholesterol and fats and it can be affecting dietary safety of the Brazilian people. (Table 3 and Pictures a, b and c).
Based on Figure 1, skin has direct influence on the level of saturated fat in poultry meat, and for this reason it should be removed before meat preparation, because it permeates the meat during preparation. Grilling or boiling meat prevents re-absorption of the liberated fat when heated up, therefore the water used in the cooking process or grease in the frying process should not be reused, so that there is no fat re-absorption.

According to the Brazilian Union of Poultry (UBA), the consumption of chicken per capita that was 8.9 kg in 1985 grew to 32.1 kg in 2000. In the metropolitan areas the relative contribution of chicken in the total availability of energy, grew from 2.5% in 1988 to 3.2% in 1996. The methods of cooking can be a significant source of additional calories and lipids, mainly because the skin is used in the preparations. In addition, the most popular recipes (fried, Milanese, stewed) add a lot of calories to the dish at the
end, causing high rates of LDL cholesterol (lipoprotein of low density), commonly known as bad cholesterol, because its excess can cause arteriosclerosis.

The consumer’s behavior in relation to chicken meat is based, on one hand in the characteristics of the product and on the other hand in the relation of prices between that product and its casual substitutes. With the constant concern in balancing meals, chicken meat is one of the main sources of protein. It should be present in the daily diet, excepting for the restrictions associated to the population income distribution profile.

Figure 2: Frequency of morbidity according to IMC of the people that consumption chicken three times for week – Viçosa, Brazil, 2002.

Table 2 - Frequency of Hypercholesterolemia and Hypertriglyceridaemia in individuals over 20 years of age. Viçosa, MG, Brazil. 2000.

<table>
<thead>
<tr>
<th>Morbid</th>
<th>Frequency</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Men</td>
<td>Women</td>
<td>Total</td>
<td></td>
</tr>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Hipercholesterolemie</td>
<td>8</td>
<td>14,5</td>
<td>49</td>
<td>38,6</td>
</tr>
<tr>
<td>Hipertrigliceridemia</td>
<td>3</td>
<td>5,5</td>
<td>16</td>
<td>12,6</td>
</tr>
</tbody>
</table>
Table 3 - Total cholesterol and total fat in poultry as affected by preparation.

<table>
<thead>
<tr>
<th>Preparation</th>
<th>Cholesterol</th>
<th>Total Fat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw without skin</td>
<td>267,23</td>
<td>422,38</td>
</tr>
<tr>
<td>Raw with skin</td>
<td>278,40</td>
<td>2043,91</td>
</tr>
<tr>
<td>Cooked without skin</td>
<td>298,82</td>
<td>659,04</td>
</tr>
<tr>
<td>Cooked with skin</td>
<td>293,14</td>
<td>1915,58</td>
</tr>
<tr>
<td>Fried without skin</td>
<td>260,42</td>
<td>1004,82</td>
</tr>
<tr>
<td>Fried with skin</td>
<td>266,90</td>
<td>2227,18</td>
</tr>
<tr>
<td>Grilled without skin</td>
<td>304,18</td>
<td>764,88</td>
</tr>
<tr>
<td>Grilled with skin</td>
<td>307,01</td>
<td>1748,85</td>
</tr>
</tbody>
</table>

**RELATION OF PRESENT STUDY TO THE LITERATURE**

In the last decades, the interest in the relationship between diet and disease is increasing (CIORLIA et al, 1997). Aiming at this, nutritional epidemiological stands out as a branch of the science of epidemiologist that studies such relationships, as well as the occurrence of those diseases in the population. It provides information so that one can formulate policies of promotion, prevention, recovery and maintenance of the dietary safety and health condition.

In 1947, through the first food world research carried out by Food and Agriculture Organization (FAO) it was initiated the evaluation of nutritional conditions worldwide (MINISTRY OF HEALTH OF BRAZIL, 2000).

Investigating dietary habits and nutrient consumption as well as the occurrence and distribution of diseases in a population, are fundamental steps to understand the existent relationships between food and diseases.

Human’s dietary habits are formed by the interaction of socioeconomic, biological and cultural factors, and within a society these factors can act differently on its constituent groups. For instance, within poorer groups of modern society, income is the main determinant of dietary habits, once the purchase of each item of the diet depends on market prices (KANNEL, 1983).

The effect of the excessive or insufficient consumption of nutrients is related to a number of diseases, especially the chronic ones. Investigating diet quality or, level of constituent nutrients is becoming more and more important. Currently, the relationships between some nutrients and specific diseases are known, standing out the concern with the consumption of saturated fats and cholesterol, the hypercholesterolaemie and heart disease risk (FONSECA et al, 1999).

Available information on food consumption of the Brazilian reveals a worrisome situation. Studies indicate changes in the Brazilian dietary pattern between the 70s and 80s. Comparing the ENDEF data and the ones from the Family Budget Survey (POF,
1987/88) MONTEIRO et al (1995), one can see an increase in the consumption of lipids and a decrease in the consumption of complex carbohydrates.

From a nutritional perspective, food focuses on its constituents (carbohydrates, proteins, lipids, vitamins, minerals and fibers) that are essential to health and quality of life. In 1995, Monteiro reported the existence of few studies correlating serum levels of cholesterol with income that showed a not much expressive association between income and hypercholesterolemia. In 1998, according to LESSA and coworkers, national researches showed that better socioeconomic condition has higher rates of hypercholesterolemia or other dislipidemic.

In relation to food consumption per capita (product purchased) many changes have occurred: the consumption of rice, bean, fruit, bread, milk, egg, yogurt, fish, sweets and wheat flour has been reduced, but the consumption of chicken, biscuits and sweet loaves, ready-made food, cheese, beer and sodas has been increased (VASCONCELOS, 2000).

MONTEIRO et al (2000) analyzed the change in the diet composition of families from metropolitan areas of Brazil using data obtained by the Family Budget Survey (POFs) of 1988 and 1996. The following modifications were found: increase in the relative participation of lipids in the diet of the North and Northeast populations; increase in the consumption of saturated fatty acids in all the studied metropolitan areas; decrease in the consumption of complex carbohydrates and increase in the consumption of sugar; slight decrease in the consumption legumes, vegetables and fruit in the country; and decrease in the consumption of eggs and the proportion of lipid calories in the Center-South of the country.

BARRETO (1996) studied the composition of food expenses in the municipality of São Paulo in the 90s. He reported a relative increase in the expenses with industrialized products and a clear reduction in the expenses with semi-prepared and fresh (vegetables and fruits) products, in spite of the relative price fall of those items.

Cholesterol plasma level can have a direct relation with the amount of cholesterol and saturated fatty acids ingested through diet. MARTINS et al (1994) studied a representative sample population of two areas of the municipality of Cotia (SP). Through the application of a diet questionnaire (personal diet history) they verified that 37 to 50% of men and 20 to 32% of women consumed cholesterol above the recommendations of National Cholesterol Education (NEP) (300mg/day). The proportion of people consuming lipid calories above recommended (30% of GET) varied from 25 to 40% of men and 45 to 50% of women. The participation of saturated fatty acids (SFA) in the diet was relatively low for both genders. Only 5 to 17% of men and less than 10% of women consumed a diet with equal or superior amounts to 10% of SFA. The authors concluded that for most of the population the diet represents a probable risk factor for heart diseases, dislipidemic and obesity. FORNES et al (2002) found a positive correlation between the consumption of food rich in cholesterol and saturated fat and the serum levels of total and LDL cholesterol. In this study a negative correlation between the consumption of food of vegetable origin and serum levels of total cholesterol and LDL-cholesterol was also observed.
The fact is that the Brazilian population has been undergoing important changes in its dietary habits and lifestyle in the last decades. On the one hand we have an increase in energy consumption, mainly by the increase in lipids between 1975 and 1989, but on the other hand sedentary life is increasing. The industrialization in 40 years caused an inversion between rural and urban population in Brazil. Rural workers used to hand-work begin to use machines that are becoming more and more sophisticated with the passing years and demanding less physical effort. Technological developments create improvements that affect people’s daily life in every way (moving around, working, household activities etc.). Technology generates comfort, which should be a synonym for well-being and better quality of life. However, comfort can also lead to a decrease in expending energy that allied to an excessive food consumption contributes to the onset of diseases and the consequent decrease in quality of life.

Epidemic studies have showed a high relationship between cholesterol concentration and the development of diseases. The relationship between cholesterol and diet is the theme of many studies and a serious problem to be faced by Brazil’s and World’s Public Health.

Hypercholesterolemia

Hypercholesterolemia is the rise of total cholesterol, commonly represented by the increase of LDL-cholesterol (SANTOS, 2001). Other fractions of cholesterol such as the lipoproteins (VLDL, IDL, HDL, chylomicron) are involved in the origin of this pathology.

Hypercholesterolemia can be attributed to one of the four factors: disorders of the lipid metabolism, diet, hyperlipidemic diseases and effect of drugs.

There are two sources of cholesterol in the intestine: the external, derived from food ingestion, and the endogenous, produced by the liver going by the small intestine along with bile. Reduction of cholesterol absorption makes its synthesis increase in the liver, but it also increases the number of LDL/receptors, consequently it reduces total values and LDL-cholesterol, keeping unaffected values of HDL-cholesterol (COSTA et al., 2000).

Hypercholesterolemia can be associated to other diseases, including endocrine, renal and hepatic disorders. Frequently, high cholesterol is identified after disease diagnosis, such as diabetes and nephritic syndrome. However, for hypothyroidism, the hypercholesterolemia is identified firstly, because there is an accumulation of LDL-cholesterol due to the decrease in the corresponding number of hepatic receptors to LDL-cholesterol (SANTOS et al., 2001). Patients with forms of secondary hypercholesterolemia, should have the primary disease treated before (BERTOLAMI, 2000).

Pathological studies have shown that atherome plates contain significant cholesterol levels and they are identified as atherogenic lipid particles of LDL-cholesterol (BERTOLAMI, 2000).
Lipoproteins

Lipoproteins are macromolecule complexes consisting of several combinations of cholesterol, fatty acids and proteins. Many of their functions are the regulation of cholesterol and fatty acids movement to and from different tissues (MAHAN & STUMP, 1998).

Lipoproteins are divided in five groups and classified according to density. English acronyms are used to name them worldwide: chylomicrons, VLDL (very low-density lipoproteins), IDL (intermediate density lipoprotein), LDL (low-density lipoprotein) and HDL (high-density lipoprotein) (SANTOS et al., 2001).

The absolute value of cholesterol fractions is not the best option to analyze lipid profile, but the proportion of each fraction in the total or the ratio between them (LDL-cholesterol/HDL-cholesterol) or between total cholesterol and HDL-cholesterol (MOURA, 2000). The reference values for plasma lipids in individuals between 2 and 19 years and above 20 years of age are described in Picture 4.

Chylomicrons - Chylomicrons are the largest and less dense lipoproteins, rich in triglycerides (SANTOS et al., 2001). They are responsible for transporting dietary lipids remnants.

| TABLE 4 - Lipid Reference Values for individuals over 20 years of age |
|---------------------------------|-----------------|---------|
| Lipids                          | Values          | Category|
| CT                              | < 200 optimum   |         |
|                                | 200 to 239 limit |         |
|                                | > or = 240 high  |         |
| LDL-C                           | < 100 optimum   |         |
|                                | 100 to 129 desirable |     |
|                                | 130 to 159 limit |         |
|                                | 160 to 189 high  |         |
|                                | > or = 190 very high |      |
| HDL-C                           | < 40 low        |         |
|                                | > 60 high       |         |
| TG                              | < 150 optimum   |         |
|                                | 150 to 200 limit |         |
|                                | 200 to 499 high |         |
|                                | > or = to 500 very high | |

Source: Brazilian Society of Cardiology (Department of Atherosclerosis), 2001.

absorbed in the intestine to blood plasma (MARANHÃO, 2000), being their that are fragments rich in cholesterol, the cause of atherosclerosis, mainly the esterifies ones (BERTOLAMI, 2000).

VLDL (very low-density lipoproteins) - lipoprotein containing more triglyceride than cholesterol, it transports the lipid from liver to periphery (MAHAN & STUMP, 1998).

IDL (intermediate density lipoprotein) - formed by VLDL catabolism, later they are captured by receptors in the liver or turned into LDL. Their high levels, together with high VLDL, are directly related to the lesion progression and coronary events (MAHAN & STUMP, 1998).
LDL (low-density lipoprotein) - cholesterol primary carriers in the blood, being their high levels associated to the increased risk of heart disease (MAHAN & STUMP, 1998). As it happens with sufferers from familiar hypercholesterolemia, larger and less dense particles of LDL-cholesterol can lead to atherogenesis (BERTOLAMI, 2000). The presence of accentuated hypercholesterolemia is accompanied by the accumulation of LDL-cholesterol in the plasma compartment, which is the main fraction of total cholesterol (LESSA et al., 2001; SANTOS et al., 2001).

HDL (high density lipoprotein) - the function of HDL-cholesterol is to combine with the cells, receive the cholesterol and take it to the liver to be excreted in bile and feces. They protect LDL-cholesterol from oxidation, since they are rich in anti-oxidizers substances (BERTOLAMI, 2000).

It is believed that HDL is involved in the transport of the excess of cholesterol from the membranes to the lipoproteins rich in triglycerides, being then removed by receptors in the liver. This process helps the organism to get rid of the cholesterol and it prevents lipid accumulation in the arteries (MAHAN & STUMP, 1998). HDL-cholesterol acts as a protection factor in the atherosclerotic process (MOURA et al., 2000).

Relationship between LDL and HDL-cholesterol - the higher the LDL-cholesterol, the more frequent the arteriosclerosis disease (WATERS, 2001). The inverse happens when the levels of HDL-cholesterol are high, what happens in both genders, all the races and ethnic groups, and in all adult ages. The effect of HDL is greater for women, but the effects of cholesterol and LDL are smaller. These relations tend to modify with age (LESSA et al., 2001; HUNNINGHAKE et al., 2001). Woman's susceptibility can be explained by the high prevalence of risk factors in the Brazilian female population, associated to an inadequate control of those factors (SANTOS & MARANHÃO, 1998). The ratio between total cholesterol and HDL, and between LDL and HDL, constitutes respectively the indexes of risk II and I proposed by Castelli (Table 3). Their use is restricted to population analyses, because when used individually, it can lead to doubtful interpretations particularly when extreme levels of variables are considered (NOVAZZI et al., 1997).

Lipoprotein A - lipoprotein (a) is cholesterol rich, similar to LDL-cholesterol, it is considered a potential factor of high levels of LDL-cholesterol, of its harmful effects, and antagonizes the beneficial effects of high levels of HDL-cholesterol. It is considered a high-risk marker for coronary disease (SANTOS & MARANHÃO, 2000). Prospective studies have showed that lipoprotein (a) represents an independent factor of risk for coronary atherosclerosis, since it does not possess any function in the transport of lipids and its absence in the plasma does not cause metabolic disorder (SANTOS et al., 2001).

Polyunsaturated Fatty Acids

In lipid metabolism, the w-3 fatty acids act in the reduction of serous triglycerides by decreasing the hepatic synthesis of VLDL-cholesterol and apo B, and increasing HDL-cholesterol. However, these alterations depend on the basal values and the given doses (COSTA et al., 2000).
SANTOS et al. (2001) reported that polyunsaturated fatty acids reduce total cholesterol and plasma LDL-cholesterol through smaller production and greater LDL elimination, and alteration of the LDL structure in order to reduce the contents of cholesterol in the particle. The w-3 fatty acids reduce the VLDL plasma triglyceridaemie. However, they suggest that the same have the inconvenience of lowering HDL-cholesterol plasma levels and inducing greater lipid oxidation. Monounsaturated fatty acids equally reduce cholesterol, and yet without reducing the HDL-cholesterol and causing lipid oxidation.

**Cholesterol and diet**

National studies determining fat and cholesterol ingestion show that most children and adolescents exceed the recommendations for consumption of total and saturated fat, and cholesterol. Rabelo and coworkers (1999) reported that 73.6% of São Paulo's sample showed total fat consume superior to 30% of the total calories. Ingestion of cholesterol equal to or greater than 300mg/day was observed in 32.7% of the 17-19 year-old sample. As for Rio de Janeiro (FONSECA et al., 1999), great differences were observed in the dietary habits according to age and sex. Young people presented a less healthy diet than those in a superior age group did. The difference between men and women’s dietary habits was also great, being more remarkable among the young ones. The consumption of food rich in saturated fat and cholesterol was significantly greater among male individuals (RABELO, 2001).

Dietary cholesterol induces change in the cell membrane composition and affects chemical and physical properties as fluidity and insulin receptors influencing the physiologic process (BHATHENA et al., 2001).

The consumption of calories in excess, saturated fats, cholesterol and animal protein can lead to an increase in the levels of total cholesterol and LDL-cholesterol in the blood. These levels can be reduced by reducing body weight, substituting saturated fatty acids by polyunsaturated, and increasing dietary fiber, mainly the soluble fraction, which presents hypcholesterolaemic effects, being capable of reducing coronary diseases (DUARTE & COSTA, 1997).

Cholesterolamie is influenced by genetic and dietary factors, especially the ingestion of saturated fats and cholesterol in smaller amount (ÁLVAREZ et al., 2000).

**Conclusion**

Certainly, there are the so-called invisible economical losses, which need better evaluation for the benefit of the Poultry Industry production, health and dietary safety. Restricting poultry skin consumption through legislation is maybe the best solution, but it would affect negatively the sector’s production-productivity. It was sought to develop a study aiming at same time a better quality of life for the consumer by restricting the use of chicken skin in the diet, and opting for larger profitability through the transformation of skin in treated leather.

The skin is definitely the part with the largest amount of fat and cholesterol. Collected data allowed to infer on economical viability and their benefits for the consumer and the leather, being still necessary to analyze the constituents, specifically
the quantification of fat before its processing and the use of natural dyes extracted from tropical fruits to color them.

Chicken skin is regularly consumed, fried or in other preparations, in many regions of Brazil and its social meaning has to be studied and evaluated, since it is rich in cholesterol and fats that can affect the dietary safety of Brazilians.

In Viçosa, the hypercholesterolemia and hypertriglyceridaemia frequency in individuals over 20 years of age is quite elevated and the largest rates occur in women.

Final considerations

It is necessary a standard questionnaire to evaluate the ingestion of lipids in different population groups - children, adolescents, adults and elderly people. It is also necessary to associate hypercholesterolemia with consumption habits of chicken skin in different preparations, evaluating the consumption with and without skin. A model of a questionnaire that included the use of chicken in different preparations would be provided. In addition, this questionnaire would evaluate the ingestion of lipids derived from chicken consumption per capita. Besides, it would be possible:

· to study constituents - fats and fatty acids present in the skin and their possible effects on health.
· to inform the consumer about the different forms of preparations.
· to propose the inclusion of skin removal and use on a industrial scale in the slaughtering system.
· to carry out a nutritional-epidemic study of chicken skin consumption, at population level, where one can evaluate habits, forms of preparations, experimentation with laboratory animals.
· to use natural dye extracted from tropical fruits for coloring the leather.

References


