Physico-chemical and sensory characterization of mincemeat culinary product with low fat

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Received: 17 February 2013; Accepted: 29 March 2013

Abstract

Evolution of human society to unhealthy eating, which increases the incidence of obesity and cardiovascular disease, has determined the experts in the meat industry to find solutions that reduce the cholesterol in meat products. Research conducted in recent years in the meat industry followed the replacing of animal fats with fats (oils) vegetable rich in essential fatty acids mono- and polyunsaturated. The additions of vegetable oils in formulations meat products change, however, their sensory characteristics.

Our research is followed to obtain poultry meat mince with vegetable oil and dietary fibers added (inulin), the proportions of oil going up to total replacement of animal fat from the recipe.

Compositions were characterized by physico-chemical, biochemical and sensory, pursuing the reaction of tasters to the perception of such products.

Achieving culinary product type mincemeat with partial replacement of fat on recipe with vegetable oils and incorporation of fiber has resulted in products with optimal rheological characteristics, sensory aspects and nutritional benefits on human health.

Keywords: poultry mincemeat, sun flower oil, canola oil, walnut oil, inulin, sensory characteristics.

1. Introduction

Evolution of human society to unhealthy eating, which increases the incidence of obesity and cardiovascular disease, has determined the experts in the meat industry to find solutions that reduce the cholesterol in meat products. Research conducted in recent years in the meat industry followed the replacing of animal fats with fats (oils) vegetable rich in essential fatty acids mono- and polyunsaturated.

It was observed that for the balance of the human diet exist certain correlations between macronutrients and biologically active substances in aliments, which ensure normal function of the body.

Special attention is paid to the contribution of essential substances, which are not synthesized in the body or are synthesized in limited quantities. [1,23]

Lipids are one of the essential food components, which largely determine the nutritional qualities, biological, energy value and the taste of food. The main factor that characterizes the efficiency of assimilation of dietary lipids in the body is the balance between the ratio of fatty acids [2, 3, 24].

Roles to play have polyunsaturated fatty acids and their excluding from the diet can affect the balance of vital processes. The fatty acid composition is an important characteristic of malnourished; their value is not determined only by their quantity. The rational combination of several sources of lipids in the development of new types of food has important
significance in terms of the economy; we also took into account the medical and biological aspects that reflect the creation of balanced food according to nutritional and biological value. [4, 5]

A precious lipid material is the walnuts oil, rich in antioxidants, but also ω-3 and ω-6 polyunsaturated fatty acids. [6, 7, 8, 24]

Another tip of oil which is low in saturated fat and contains both omega-6 and omega-3 fatty acids in a ratio of 2:1 is canola oil. If consumed, it also reduces low-density lipoprotein and overall cholesterol levels, and as a significant source of the essential omega-3 fatty acid is associated with reduced all-cause and cardiovascular mortality.[9] It is recognized by many health professional organizations including the Academy of Nutrition and Dietetics and American Heart Association.[10, 11, 12, 13]

Canola oil has been given a qualified health claim from the United States Food and Drug Administration due to its high levels of cholesterol-lowering fats. [14]

The additions of vegetable oils in formulations meat products change, however, their sensory characteristics.

Our research is followed to obtain mince poultry with vegetable oil and dietary fibers added (inulin), the proportions of oil going up to total replacement of animal fat from the recipe.

Compositions were characterized by physico-chemical, biochemical and sensory, pursuing the reaction of tasters to the perception of such products.

Achieving culinary product type mincemeat with partial replacement of fat on recipe with vegetable oils and incorporation of fiber has resulted in products with optimal rheological characteristics, sensory aspects and nutritional benefits on human health.

We study the effect of the addition of vegetable fats on the structure and consistency of meat compositions, how these changes affect the taste and appearance of these products, thereby influencing acceptability by consumers. The products have been designed for the catering sector.

2. Materials and Methods

Composition of mince poultry used in determining comprises, basically, boneless and fat meat, lard, inulin, salt, spices and water. In experiments we used poultry breast meat commercially. Each batch of meat was minced and then divided into five samples, including a control. In each sample was added the quantity of minced fat established from the procedures.

It was added salt and inulin, the components were mixed and then it was incorporated the water.

Samples were kept refrigerated for 24 hours, then was added the oil provided for each experiment.

Form experiments followed the gradual replacement of the quantity of fat added into the meat with oil (Table 1).

<table>
<thead>
<tr>
<th>Table 1. Scheme of experiments (%)</th>
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</thead>
<tbody>
<tr>
<td>Ingredient</td>
</tr>
<tr>
<td>------------</td>
</tr>
<tr>
<td>Mince poultry</td>
</tr>
<tr>
<td>Back fat</td>
</tr>
<tr>
<td>Oil</td>
</tr>
<tr>
<td>Inulin</td>
</tr>
<tr>
<td>Salt, spices</td>
</tr>
</tbody>
</table>

We used three types of vegetable oils: sunflower oil, canola oil and walnuts oil, purchased directly from authorized dealers. To balance the composition was added inulin.

At each sample we used the same amount of water for hydration the inulin and ice flakes, salt and thyme as a spice. Analyses were carried out in triplicate.

Analytical methods. The chemical composition of poultry meat utilized for analyses was determining by following methods:

- water content: according to the AOAC - 1995 method;
- total nitrogen content: according to the SR ISO 9037:2007 standard;
- fat content: according to the AOAC - 1984 method;
- carbohydrates: STAS 91-83, Bertrand method;
- ash was determined to constant weight by asking the sample at 525 ± 25°C.
**Determination of pH**: it was measured in a homogenate prepared with 5 g of sample and distilled water (20 ml) using a pH meter (Model 340, Metter-Toledo GmbH).

**Cooking losses** (**CL**): samples raw were weighed and then were placed in a heated oven at 250°C for 30 minutes, into teflon forms, with a capacity of about 30 g/each, after baking the samples were cooled and weighed again, setting the loss formula:

\[ CL = \frac{(m_i - m_f)}{m_i} \times 100, \]

where: \( m_i \) - initial mass; \( m_f \) - final mass.

**Water holding capacity**: was determined according to the method described by Fujimaki and Tsuda, by centrifuging the samples for 10 min at 3500 rev / min and weighing the moisture removed, by the formula:

\[ \text{Water holding capacity (WHC%)} = \frac{\text{moisture removed}}{\text{(sample mass – moisture removed)}} \times 100 \]

**Determination of salt**: was performed according to the Mohr method and the results were expressed as a percentage.

**Sensory analysis**: was performed by a panel of 10 food specialists from the Department of Food Science, Food Engineering and Applied Biotechnology from the "Dunarea de Jos" University of Galati.

They appreciated the appearance of section, color, texture, taste, smell and mouthfeel for a total of four variations of each type of meat composition and a control sample, for the three oils used in measurements. Panelists were performed a preferentially test for sensory analysis of the samples.

### 3. Results and Discussion

Meat is one of the most common foods with high nutritional value. Composition, protein and fat content, in particular, give the flavor of meat. Animal fat added to the compositions of meat has an important role, both technological and organoleptic point of view. For this reason, attempts to reduce the amount of fat in meat products hit, most times, the reaction of consumers who do not like the taste and texture of foods modified on this way.[15, 24]

Certain sensory qualities, taste and juicy chop are specific and derive from relatively high content of fat and a large amount of bound water.[17] Therefore, reducing the amount of fat must to be compensated by other benefits that do not worse the properties mince and allow proper water-binding capacity, resulting the improving of rheological characteristics and emulsion stability. [15, 17, 18]

**Analysis of chemical composition**

Following the scheme of experiments were performed comparative analyzes on the contents of protein, total fat, carbohydrates and water, both for the composition row and after baking. Determinations regarding the main nutrients in meat compositions which the fat were replaced with oils are shown in Table 2, 3 and 4.

The data were processed statistically, the standard deviation was calculated for the sets of determinations.

From the tables it follows that the differences in the amount of **protein** in raw meat samples have not exceeded significantly (p> 0.05) and lies within the published literature.[17, 18, 19, 24]

It was found that the variation in **lipid** content was most important, being materialized in 3.17-6.81% difference between the control samples and the row samples with oil. For baked meat composition were obtained 2.01-2.77% difference between the control and samples with oil. We believe that these differences were due to the different consistence of each oil and because each oil was embedded in different amounts in the meat mixture. And other authors have found differences of the quantity of lipids determined between the samples with different oils.[17, 18, 24]

During determinations it was revealed that although the amount of fat each sample was theoretically the same, fat increased progressively determined for the increasing in oil content of samples, the differences are about twice higher for raw samples. We assume that this behavior was due to the expulsion of a different amount of oil from the composition during the baking, as increasing of the amount of oil used, although inulin was used to correct this deficiency. Technological, we intervened in the row composition by adding ice but in the baking could not be retained the entire amount of oil incorporated in the composition of meat.

**Carbohydrates** and **ash** variations were quite small, insignificant compared to the control sample, as shown in Tables 2-4, in correlation with literature data. [17, 18, 19]
**Table 2.** Emulsion composition of mince poultry in which the fat were replaced with sunflower oil (%)

<table>
<thead>
<tr>
<th>Component</th>
<th>Control</th>
<th>Sample 1</th>
<th>Sample 2</th>
<th>Sample 3</th>
<th>Sample 4</th>
<th>Control</th>
<th>Sample 1</th>
<th>Sample 2</th>
<th>Sample 3</th>
<th>Sample 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Proteins</strong></td>
<td>11.89± 0.73</td>
<td>11.25± 0.62</td>
<td>11.39± 0.52</td>
<td>11.90± 0.78</td>
<td>11.73± 0.92</td>
<td>14.21± 0.53</td>
<td>13.70± 0.84</td>
<td>14.30± 0.92</td>
<td>13.90± 0.87</td>
<td>13.80± 0.98</td>
</tr>
<tr>
<td><strong>Lipids</strong></td>
<td>20.79± 0.64</td>
<td>21.22± 0.12</td>
<td>21.19± 0.00</td>
<td>21.37± 0.85</td>
<td>21.45± 0.49</td>
<td>33.95± 0.62</td>
<td>34.13± 0.34</td>
<td>34.10± 0.78</td>
<td>34.50± 0.29</td>
<td>34.63± 0.37</td>
</tr>
<tr>
<td><strong>Carbohydrates</strong></td>
<td>0.85± 0.02</td>
<td>1.17± 0.10</td>
<td>1.28± 0.03</td>
<td>1.27± 0.00</td>
<td>1.28± 0.08</td>
<td>1.60± 0.09</td>
<td>1.80± 0.02</td>
<td>2.20± 0.11</td>
<td>2.40± 0.01</td>
<td>2.40± 0.12</td>
</tr>
<tr>
<td><strong>Ash</strong></td>
<td>1.19± 0.01</td>
<td>0.99± 0.00</td>
<td>0.99± 0.07</td>
<td>0.98± 0.02</td>
<td>0.85± 0.05</td>
<td>1.53± 0.03</td>
<td>1.69± 0.04</td>
<td>1.43± 0.02</td>
<td>1.35± 0.01</td>
<td>1.72± 0.05</td>
</tr>
</tbody>
</table>

*Control* – with back fat; *P1* - 33.3% oil; *P2* - 66.6% oil; *P3* - 83.3% oil; *P4* - 100% oil

**Table 3.** Emulsion composition of mince poultry in which the fat were replaced with canola oil (%)

<table>
<thead>
<tr>
<th>Component</th>
<th>Control</th>
<th>Sample 1</th>
<th>Sample 2</th>
<th>Sample 3</th>
<th>Sample 4</th>
<th>Control</th>
<th>Sample 1</th>
<th>Sample 2</th>
<th>Sample 3</th>
<th>Sample 4</th>
<th>Control</th>
<th>Sample 1</th>
<th>Sample 2</th>
<th>Sample 3</th>
<th>Sample 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Proteins</strong></td>
<td>12.07± 0.64</td>
<td>11.73± 0.63</td>
<td>11.39± 0.41</td>
<td>11.56± 0.80</td>
<td>11.14± 0.77</td>
<td>14.21± 0.45</td>
<td>13.70± 0.78</td>
<td>14.30± 0.53</td>
<td>13.90± 0.69</td>
<td>13.90± 0.87</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Lipids</strong></td>
<td>21.30± 0.52</td>
<td>22.20± 0.45</td>
<td>22.58± 0.71</td>
<td>22.40± 1.02</td>
<td>22.75± 0.83</td>
<td>33.90± 0.48</td>
<td>34.02± 0.27</td>
<td>34.11± 0.65</td>
<td>34.84± 0.84</td>
<td>34.74± 1.07</td>
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<td></td>
</tr>
<tr>
<td><strong>Carbohydrates</strong></td>
<td>1.11± 0.04</td>
<td>0.77± 0.02</td>
<td>1.14± 0.02</td>
<td>1.19± 0.01</td>
<td>1.28± 0.05</td>
<td>1.90± 0.02</td>
<td>1.60± 0.01</td>
<td>1.50± 0.06</td>
<td>1.60± 0.02</td>
<td>2.00± 0.08</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Ash</strong></td>
<td>0.94± 0.01</td>
<td>0.82± 0.03</td>
<td>0.99± 0.02</td>
<td>1.10± 0.02</td>
<td>1.10± 0.02</td>
<td>1.73± 0.00</td>
<td>1.59± 0.04</td>
<td>1.63± 0.03</td>
<td>1.45± 0.01</td>
<td>1.52± 0.02</td>
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</tr>
</tbody>
</table>

**Table 4.** Emulsion composition of mince poultry in which the fat were replaced with walnuts oil (%)

<table>
<thead>
<tr>
<th>Component</th>
<th>Control</th>
<th>Sample 1</th>
<th>Sample 2</th>
<th>Sample 3</th>
<th>Sample 4</th>
<th>Control</th>
<th>Sample 1</th>
<th>Sample 2</th>
<th>Sample 3</th>
<th>Sample 4</th>
<th>Control</th>
<th>Sample 1</th>
<th>Sample 2</th>
<th>Sample 3</th>
<th>Sample 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Proteins</strong></td>
<td>12.24± 0.50</td>
<td>12.12± 0.92</td>
<td>12.16± 0.55</td>
<td>12.50± 0.61</td>
<td>12.12± 0.84</td>
<td>14.40± 0.63</td>
<td>14.00± 0.51</td>
<td>13.70± 0.83</td>
<td>13.30± 0.92</td>
<td>13.60± 0.90</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td><strong>Lipids</strong></td>
<td>20.47± 0.21</td>
<td>21.28± 0.75</td>
<td>21.25± 0.32</td>
<td>21.51± 0.94</td>
<td>21.44± 0.73</td>
<td>33.75± 0.28</td>
<td>34.23± 0.32</td>
<td>34.10± 0.10</td>
<td>34.38± 0.49</td>
<td>34.57± 0.58</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Carbohydrates</strong></td>
<td>1.36± 0.02</td>
<td>1.19± 0.01</td>
<td>1.07± 0.01</td>
<td>1.28± 0.06</td>
<td>1.53± 0.01</td>
<td>1.90± 0.03</td>
<td>1.60± 0.04</td>
<td>1.90± 0.01</td>
<td>1.90± 0.07</td>
<td>1.60± 0.03</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Ash</strong></td>
<td>1.02± 0.04</td>
<td>0.96± 0.02</td>
<td>0.92± 0.04</td>
<td>0.95± 0.01</td>
<td>0.94± 0.00</td>
<td>1.20± 0.05</td>
<td>1.39± 0.02</td>
<td>1.27± 0.01</td>
<td>1.35± 0.03</td>
<td>1.22± 0.01</td>
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</tr>
</tbody>
</table>
pH
The pH value of the composition of raw meat increased from the control sample, with the increasing of the oil amount, with 0.04-0.12 units for sunflower oil samples, with 0.09-0.26 units for walnuts oil and with 0.03-0.20 units for canola oil samples of each composition. [17] Baking samples prompted further increasing the pH values, but with small values, ranging between 0.04-0.19 units, as can be seen from Figure 1.

It is found that the losses vary quite a bit depending on the type of oil used, but decreases almost linearly with increasing the amount of oil that replaces the animal fat in the recipe.

Compared to the control sample, variations of cooking losses are different (Table 5), the average difference is 2.77% for canola oil, 2.31% for samples with sunflower oil, and 1.84% for samples with canola oil. It follows that the lowest average loss is recorded for mince poultry with canola oil and the higher for the mince poultry with sunflower oil.

Table 5. Average of cooking losses of mince poultry with oil, related the control (%)

<table>
<thead>
<tr>
<th>Oils</th>
<th>Sample 1</th>
<th>Sample 2</th>
<th>Sample 3</th>
<th>Sample 4</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sunflower oil</td>
<td>2.69</td>
<td>3.74</td>
<td>1.59</td>
<td>3.05</td>
<td>2.77</td>
</tr>
<tr>
<td>Canola oil</td>
<td>2.63</td>
<td>3.59</td>
<td>1.17</td>
<td>2.58</td>
<td>1.84</td>
</tr>
<tr>
<td>Walnuts oil</td>
<td>1.18</td>
<td>2.50</td>
<td>4.37</td>
<td>2.35</td>
<td>2.31</td>
</tr>
</tbody>
</table>

Control – with back fat; P1 - 33.3% oil; P2 - 66.6% oil; P3 - 83.3% oil; P4 - 100% oil

Water holding capacity (WHC)

It notes that the content of fat and the water is inversely related, found by other researchers, this effect associated with the presence of fiber (inulin) and oil replacement. [18, 25]

Measurements were performed for both, raw and baked meat mixture, for all three variants of oil. From Figure 3 it follows that the composition of the raw samples show large variations depending on the amount of oil incorporated in the sample, but they fall within the limits published in the literature. [18]
Although initial values for canola oil samples had higher WHC with approx. 20% compared to the others, WHC of the samples with 25 and 30% sunflower oil samples have exceeded with about 25% the samples with walnuts oil and with 9.5% the samples with canola oil. The situation was repeated on the same samples with sunflower oil baked, the increase of WHC was about 19%, which shows that sunflower oil is recommended to be used in getting chips with added vegetable fats, in over other types of oil.

**Sensory analysis**

Baked samples of each type of meat composition were analyzed by group of 10 sensory panelists, who gave grades from 1 to 5 for each attribute examined. Overall score of the alternatives did not exceed the average and the notes were pretty close in value (Fig.4d).

*Appearance* was well perceived by the panelists, the average mark for the shape of each of the three types of mince meat with oil being 4.3, 4.5 and 4.22. Color was rated with lower average grades, 2.7, 2.8 and 2.70, it was considered less satisfactory (Fig. 4, a, b, c). The worst was estimated the color for all variants of the mince meat with maximum oil added. In fact, the experiment did not seek to correct or mitigate certain deficiencies of mince meat with oil. The view was to not conceal anything with seasoning or coloring too strong but to verify the real qualities of mince meat with oil.

*Appearance in section* was analyzed from several points of view. Color section received modest average grades of 2.99, 3.05 and 2.97, compared to the structure, which was rated with higher scores respectively 3.74, 3.85 and 3.12. And texture was assessed with grades higher than the average, respectively 3.57, 3.45 and 3.27, mainly for control samples and increasingly weaker for those with increasingly more oil. Overall this attribute received a good average grade of 3.43, 3.45 and 3.12, noting that the samples with walnuts oil were rated lowest (Fig. 4, a, b, c).

*Smell* of preparations chips types was listed by 10% weaker, receiving notes 3.06, 2.99 and 3.01. The smell of baking was considered the most unsatisfactory, especially for samples with sunflower oil.

**Figure 4.** Sensory profile of the composition of mince meat with low fat
Control (M) – with back fat; P1 - 33.3% oil; P2 - 66.6% oil; P3 - 83.3% oil; P4 - 100% oil; SO - sunflower oil; CO - canola oil; WO - walnut oil.
Mouthfeel was appreciated and noted with 3.75, 3.45 and 3.40, tenderness was rated best from all the elements analyzed for the mince meat. The particle retention on teeth received low grades, around 2.5. The lowest score was given to the samples with the highest amount of fat replaced (Fig. 4, a, b, c). Besides, other researchers reported that huge reduction in the amount of animal fat leads to the rejection of products. [21, 26, 28, 29]

The taste was not considered satisfactory and received grades below respectively 2.48, 2.42 and 2.58, all panelists highlighted the bad taste for sweet, sour, but mostly bitter. No salty taste was not appreciated, although determinations showed that salt levels did not exceed the allowed limit, ranged between 0.85-1.05% (Figure 5).

Aftertaste was assessed with the same average grade for all types of pasta, 3.22, namely from the oily feeling of the meat products. [21, 24,25, 30]

However it can be seen from Figure 4 (a, b and c) that the control samples obtained the lowest grades, with 25-30% lower compared to samples with the highest amount of oil incorporated.

General appreciation of the sensory qualities of meat compositions was under note 3, namely 2.89 for meat composition with sunflower oil, 2.82 for meat composition with canola oil and 2.75 for the composition of meat with walnuts oil (Fig. 4, d). [26,27, 28, 30]

![Figure 5. Salt content in compositions of low-fat meat (%)](image)

Control – with back fat; P1 - 33.3% oil; P2 - 66.6% oil; P3 - 83.3% oil; P4 - 100% oil

The score given to the preferential test showed that, from the total number of 10 panelists, six prefer products with sunflower oil, four prefer products with canola oil, none chose mince meat with walnuts oil.

4.Conclusions

To reduce the incidence of cardiovascular disease, diabetes and certain digestive disorders is necessary to reduce the level of animal fat in meat products. However the amount of animal fat in mince meat products defines the physical and chemical properties and the sensory qualities of them. Replacing part of the animal fat in mince meat with vegetable oils, sunflower, canola or walnuts, may be an option for getting healthier products.

Adding dietary fiber, inulin in our case, can compensate drawbacks of technological properties and sensory qualities, the determinations showed that increased cooking losses, although increased WHC. From this point of view, sunflower oil is recommended to be used in getting chips with added vegetable fats, in over other types of oil.

Compositions of meat with sunflower oil were better accepted than those with canola oil and walnuts, although the latter have more valuable features and content on nutritional intake of ω-3 and ω-6 polyunsaturated fatty acids, even the ratio in which they are found. Meat with oil compositions, particularly those in which replaced up to 60% of added animal fat with vegetal oils were pretty well accepted by consumers.

It follows that aftertaste was favorable to products with oils. So, by educating taste might get greater consumer acceptance for this type of products.

Compliance with Ethics Requirements

Authors declare that they respect the journal’s ethics requirements. Authors declare that they have no conflict of interest and all procedures involving human and/or animal subjects (if exists) respect the specific regulations and standards.

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