Effects of diets supplemented with grass meal and sugar beet pulp meal on abdominal fat fatty acid profile and ceacal volatile fatty acid composition in geese

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SUMMARY

Two hundred and twenty-five unsexed day-old native Turkish goslings were divided at random into 3 groups, each with 5 subgroups consisting of 15 chicks. One of the groups was fed only starter (0-6 weeks) and grower (7-12 weeks) diets (Control) and complete parts of these diets were replaced with grass meal (GM Group) and dried sugar beet pulp meal (SBP Group) by 10 % at starter and by 20 % at grower period. After the sixth and twelfth weeks, 6 randomly selected geese from each subgroup, were slaughtered for determination of abdominal fatty acids compositions and ceacal volatile fatty acids concentrations. The total saturated fatty acids (SFA) and monounsaturated fatty acids (MUFA) concentrations in the abdominal fat were not affected by the feeding regimes at the end of the 6 weeks, while polyunsaturated fatty acids (PUFA) concentrations were higher in the GM and SBP groups than that of the control group.

At the end of the 12 weeks, total SFA concentrations was higher in the GM and SBP groups than that of the control group, whereas the total MUFA concentrations was opposite, the total PUFA concentrations were higher in the GM group than that of other groups. The feeding regimes did not affect the concentrations of volatile fatty acids in the ceaca at the end of the 6 weeks, while acetic acid was higher and propionic acid was lower in the GM and SBP groups than that of control at the end of 12 weeks.

Keywords : Grass - Sugar beet - Abdominal fat fatty acid Volatile fatty acid - Goose.

Introduction

Dietary fats have important implications for human health. In recent years, instead of fat, the terms saturated fatty acids (SFA), monounsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA) and their proportion to each other have come to be widely used. There is a tendency to increase MUFA and PUFA concentrations in goose abdominal fat varies from 27.2-33.0, 54.9-59.8 and 12.0-15.1 %, respectively in White Italian geese fed on a diet with a supplemented herbal mixture [4].

HSU et al., [10] found that the nature of the dietary fibre did not influence the volatile fatty acids (VFA) in geese. However, increasing the fibre from 3 to 12 % in diets kept isonitrogenous, CHEN et al., [6] found that the content of total volatile fatty acids increased.

There is a scarcity of information concerning the effect of feeding diets containing bulky ingredients on the abdominal fatty acid and ceacal volatile fatty acid concentrations in geese. The aim of the present study was to determine the effect of supplementing a diet with grass meal or dried sugar beet pulp meal on the abdominal fatty acid and volatile fatty acid profiles in native Turkish geese.
Materials and methods

ANIMALS, DIETS AND TREATMENTS

Two hundred and twenty-five unsexed day-old Turkish native goslings were divided at random into 3 groups, each with 5 replicates comprising 15 goslings. The study lasted 12 weeks and consisted of 6 weeks starter and 6 week grower periods. One of the groups (Control) was fed only concentrate diet (Table I) formulated to meet the dietary requirements of starter and grower geese [16]. Complete parts of these diets were replaced with a mixture of grass meal (GM) and dried sugar beet pulp meal (SBP) at concentrations of 10 and 20 %, respectively, during the starter and grower periods. Goslings were placed in electrically heated battery brooders from 0-14 days under continuous incandescent light. At 15 days of age, the goslings were transferred to a metallic feeding platform (1m x 2m x 85cm), which is 2 cm mesh wire floored, over a concrete floor. After the second week the study was conducted at room temperature (20°C). Feed and water were offered ad libitum during the experimental period.

SAMPLE COLLECTION

At the end of both the starter and grower periods, 6 randomly selected geese from each subgroup, were slaughtered, contents taken from both ceaca immediately and processed according to the procedure of PARKER and McMILLAN [17]. Abdominal fat samples were taken 2 hours after slaughter from the carcasses weighed and stored at -20°C until analysed for fatty acids.

CHEMICAL ANALYSES

The proximate analyses of the feed samples were carried out according to the methods of AOAC [2].

All abdominal fat samples obtained from the each subgroup were mixed homogeneously. Thus, a total of 5 samples prepared for analysis of each group. The oil fractions of the abdominal fats were determined after ether extraction [1]. These oil samples were esterified [2] and the concentration of the fatty acids were determined by gas chromatography (Thermoquest Trace GC) in TÜBITAK Marmara Research Centre, Kocaeli, Turkey. The gas chromatography was equipped with a flame ionisation detector and a SP-2330 capillary column (30 m x 0.25 mm I.D., film thickness 0.2 µm). The column temperature was 220°C, the temperature of the detector was 250°C, the temperature of injector was 240°C and nitrogen was used as the carrier gas. Qualitative determination of fatty acid methyl esters of samples were made by comparing the relative retention times obtained from fatty acid methyl ester standards provided by Sigma (St. Louis, USA).

The concentration of individual VFA components was measured according to the procedure of PARKER and McMILLAN [17]. The gas chromatography was equipped with a flame ionisation detector and a CP-WAX capillary column (25 m x 0.32 mm I.D., film thickness 0.2 µm). The column temperature was 180°C, the temperature of detector was 270°C, the temperature of injector was 250°C and nitrogen was used as the carrier gas. Qualitative determination of volatile fatty acid salts of samples were made by comparing the relative retention times obtained from fatty acid standards provided from Sigma (St. Louis, USA).

STATISTICS

Data analysis of groups were subjected to analysis of variance using « one-way ANOVA » procedures, significant differences among the treatments were determine by Duncan’s multiple range test and data analysis of the same groups at 6 and 12 weeks was performed by « t test » in SPSS [18]. Differences were considered to be significant at the 0.05 probability. Values were expressed as mean ± pooled standard errors of means (X ± SE).

Results

Abdominal fat weight of the animals did not statistically differ between the groups at sixth week and they were found to be 38.89 ± 5.25, 34.13 ± 4.74 and 33.21 ± 3.80 g in the Control, Grass meal and Sugar beet pulp groups, respectively. However, grass meal group had the highest abdominal fat weight than the other groups in twelfth week (P<0.05) which were 92.42 ± 7.43, 58.26 ± 9.99 and 74.80 ± 8.62 g respectively.

TABLE I.—Composition of goslings starter and grower diets %.

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Starter diet (g/100 g)</th>
<th>Grower diet (g/100 g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize</td>
<td>59.55</td>
<td>64.80</td>
</tr>
<tr>
<td>Soybean meal</td>
<td>30.00</td>
<td>16.40</td>
</tr>
<tr>
<td>Fish meal</td>
<td>5.00</td>
<td>-</td>
</tr>
<tr>
<td>Barley</td>
<td>2.95</td>
<td>10.40</td>
</tr>
<tr>
<td>Wheat bran</td>
<td>-</td>
<td>6.00</td>
</tr>
<tr>
<td>Limestone</td>
<td>1.25</td>
<td>1.20</td>
</tr>
<tr>
<td>Dicalcium phosphate</td>
<td>0.65</td>
<td>0.60</td>
</tr>
<tr>
<td>Salt</td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>Vit. Min. Prem. *</td>
<td>0.35</td>
<td>0.35</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Nutrients</th>
<th>Starter</th>
<th>Starter</th>
<th>Grower</th>
<th>Grower</th>
<th>Grower</th>
</tr>
</thead>
<tbody>
<tr>
<td>ME, Mj/kg**</td>
<td>12.1</td>
<td>11.3</td>
<td>11.6</td>
<td>12.1</td>
<td>10.5</td>
</tr>
<tr>
<td>Dry matter</td>
<td>92.95</td>
<td>93.47</td>
<td>93.67</td>
<td>93.06</td>
<td>94.06</td>
</tr>
<tr>
<td>Crude protein</td>
<td>23.63</td>
<td>20.95</td>
<td>20.91</td>
<td>16.34</td>
<td>14.09</td>
</tr>
<tr>
<td>Ether extract</td>
<td>3.80</td>
<td>3.72</td>
<td>3.52</td>
<td>3.49</td>
<td>3.04</td>
</tr>
<tr>
<td>Crude fibre</td>
<td>3.71</td>
<td>6.39</td>
<td>6.43</td>
<td>4.42</td>
<td>9.60</td>
</tr>
<tr>
<td>Ash</td>
<td>7.70</td>
<td>7.75</td>
<td>8.21</td>
<td>6.10</td>
<td>6.43</td>
</tr>
</tbody>
</table>

* Each 2.5 kg of vitamin-mineral premix contained: 4505 mg Vit A; 37.5 mg Vit D₃; 20000 mg Vit E; 3000 mg Vit K₃; 3000 mg Vit B₇; 5000 mg Vit B₉; 3000 mg Vit B₆; 15 mg Vit B₁₂; 25000 mg NIchotin amid; 750 mg Folic acid; 50 mg D-Biotin; 10000 mg Cal-D-Pantothenat; 60000 mg Fe; 60000 mg Zn; 5000 mg Cu; 500 mg Co; 10000 mg Mn.

** Metabolisable energy, provided by calculation
The fatty acids composition in the abdominal fat of geese is shown in Table II. In all groups saturated and mono¬unsaturated fatty acids were the predominant components in abdominal fat whereas the concentrations of polyunsaturated fatty acids were relatively small. The major saturated fatty acids were palmitic and stearic acids, the major MUFA was oleic acid and the major PUFA was linoleic acid.

Concentrations of the total SFA and MUFA were not significantly affected by the feeding regimes at the end of the 6 weeks (P>0.05), but the concentrations of the total PUFA were significantly higher in the groups fed on the diets containing both bulky feeds than in those fed on the control diet (P<0.001).

At the end of 12 weeks, concentrations of the total SFA significantly higher in both bulky feed groups than that of the control group (P<0.001), but the total MUFA was opposite (P<0.001). The concentrations of the total PUFA were significantly higher grass meal group than that of the other groups (P<0.05).

![Image of Table II](image-url)
Although the difference is not statistically significant, the concentration of the total MUFA was higher at the end of 12 weeks when compared with that obtained at the end of 6 weeks in all groups. Except for the total SFA of control group at the end of the 12 weeks, the concentrations of the total SFA and PUFA were close in all the groups in both weeks.

The compositions of individual volatile fatty acids in the caeca of geese are presented in Table III. The feeding regime did not significantly affect acetic and propionic acid concentrations at the end of the 6 weeks, whereas acetic acid was significantly higher at the end of the 12 weeks in both bulky feed groups than that of the control group (P<0.01) while propionic acid was opposite (P<0.01). Butyric acid concentration was not affected by feeding regimes both in 6 and 12 weeks. The molar percentages of acetate, propionate and butyrate were ranged 57.08 and 59.89, 23.42 and 26.57, and 11.32 and 13.61 %, respectively, among the groups regardless of the feeding period.

Discussion

In this experiment it was found that the feeding by grass meal and sugar beet pulp induced differences some of the individual and total fatty acid concentrations in the abdominal fat of geese (Table II). The total concentrations of saturated-, monounsaturated and polyunsaturated fatty acids ranged 30.30 and 33.41, 48.14 and 55.27, and 11.93 and 15.13 % for the above three respective categories of fats, over the two periods of growth (after 6 or 12 weeks) when measurements were made. These figures are in accordance with the values reported by others for the abdominal fat [4, 5, 11] and for the adipose tissue [13] of White Italian geese.

In general, fatty acids incorporated into lipids have come from two sources, either from the diet or as a result of the de novo synthesis. While long-chain saturated and monounsaturated fatty acids incorporated into tissue lipids are the products of de novo synthesis from carbohydrates, polyunsaturated fatty acids can only have been derived from the diet [7]. In the present study, because of the low fat and high carbohydrate concentrations of the diets, most of the fatty acids incorporated into the abdominal fat are likely to have been formed as a result of de novo synthesis from carbohydrates. Therefore, a high de novo synthesis of fatty acids results in higher concentrations of saturated and monounsaturated fatty acids than of polyunsaturated fatty acids. However, it might be expected that the addition of dietary oils with high concentrations of polyunsaturated fatty acids will increase the concentration of the latter in abdominal fat in much the same way as has been shown to occur in broilers [3].

The abdominal fat contents of the geese fed on the diets containing grass meal and sugar beet pulp meal had lower contents of total monounsaturated fatty acid (primarily oleic acid), but higher polyunsaturated fatty acids than that of control-fed geese at both ages examined. This finding is consistent with data from elsewhere [11]. Although BIELINSKI et al., [4] have reported that, as geese age, the concentration of total monounsaturated fatty acids in the abdominal fat decreases, this was not observed in this study.

Energy concentration of rations did not affect total saturated and monounsaturated fatty acid concentrations but significantly increased polyunsaturated fatty acid concentration of animals at sixth week. However, both bulky feeds significantly increased saturated- and polyunsaturated fatty acid concentration, but decreased total monounsaturated fatty acid concentrations at twelfth week (Table I and II).

The fatty acids composition of diets is considered an important factor in determining the quality of human health, especially in the context of cardiovascular disorders. While an increase in the intake of saturated fatty acids raises the concentration of low-density lipoprotein (LDL)-cholesterol in the blood serum, a similar increase in monounsaturated and n-6 polyunsaturated fatty acids (especially linolenic acid) lowers it [9, 15]. However, recent studies have indicated that the development of atherosclerosis does not depend solely on the cholesterol concentration in blood but also on the susceptibility of the LDLs to oxidation. In this regard, monounsaturated fatty acids reduce the susceptibility of LDLs to oxidation in both humans [15] and broilers [8]. It can, therefore be concluded that the fatty acid composition of the abdominal fat of the goose is favourable as far as human nutrition is concerned. Additionally, it can be proposed that feeding by grass meal had more advantages for human health because of the lower abdominal fat weight than the other groups at twelfth week.

<table>
<thead>
<tr>
<th>Fatty acids</th>
<th>Week</th>
<th>Control</th>
<th>Grass meal</th>
<th>Sugar beet pulp</th>
<th>Importance(^1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetic acid</td>
<td>6</td>
<td>57.08 ± 0.9</td>
<td>58.16 ±0.4</td>
<td>58.19 ± 0.6</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>57.54 ± 0.4b</td>
<td>59.89 ± 0.3a</td>
<td>59.26 ± 0.4a</td>
<td>**</td>
</tr>
<tr>
<td>Propionic acid</td>
<td>6</td>
<td>25.24 ± 0.8</td>
<td>23.63 ± 0.5</td>
<td>23.42 ± 0.6</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>26.57 ± 0.4a</td>
<td>24.45 ± 0.6b</td>
<td>25.08 ± 0.6b</td>
<td>**</td>
</tr>
<tr>
<td>Butyric acid</td>
<td>6</td>
<td>11.32 ± 0.5</td>
<td>11.97 ± 0.3</td>
<td>11.84 ± 0.2</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>12.52 ± 0.3</td>
<td>13.61 ± 0.6</td>
<td>12.27 ± 0.3</td>
<td>NS</td>
</tr>
<tr>
<td>Importance(^2)</td>
<td></td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td></td>
</tr>
</tbody>
</table>

Table III.—Volatile fatty acid ratios in the geese, molar percentage (X ± SE, n = 30).
NS: Non significant
\(^1\)(a,b) Indicates statistical differences among the means within the same row (**: P<0.01).
\(^2\)Means for the same parameters comparing with that of 6th and 12th weeks did not statistically differ.

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The volatile fatty acids derived from the caecal fermentation some what contributed to energy requirements of birds. Results from the present study showed that there had been microbial fermentation in the gese caeca (Table III). Although the feeding regime did not affect proportions of acetic, propionic and butyric acids after 6 weeks of growth, the acetic acid concentration was higher and that of propionic acid lower in groups fed on the diets containing grass meal and sugar beet pulp meal after 12 weeks. The differences between these volatile acid concentrations in the caeca can be attributed to the higher crude fibre contents of the diets containing the grass and sugar beet pulp meals (Table I). In a somewhat similar vein CHEN et al., [6] and TIMMLER [19] have reported that the total volatile fatty acid concentrations and the molar percentage of acetic and butyric acid in the caeca of gese increased while that of propionic acid decreased when the dietary fibre was increased. The differences between the studies can be attributed to differences between the ingredients in the diets, their crude fibre contents and the breed of gese.

In conclusion, the concentration of total saturated and monounsaturated fatty acids in the abdominal fat content of the gese was not affected by the feeding regimes applied in this experiment. However, that of the polyunsaturated fatty acids was increased in the abdominal fat of the gese fed on the diets containing grass meal and sugar beet pulp meal after 6 weeks. After 12 weeks, the concentration of total saturated fatty acids increased and that of the monounsaturated fatty acids decreased in the abdominal fat of the gese fed on the diets containing the grass meal and sugar beet pulp meal, while that of the total polyunsaturated fatty acids increased in the abdominal fat of the birds fed on the diet containing grass meal. It was also concluded that the abdominal fat of gese is favourable in terms of human nutrition. Finally the feeding regime had not affect the volatile fatty acid composition of the caeca at the end of the sixth week, but the proportion of acetic acid increased and that of propionic acid had decreased in the birds fed on the diets containing grass meal and sugar beet pulp meal by at the end of the twelfth week.

References


