The Effects of Different Levels of Tomato Pomace and Processing Methods on Production Performance and Blood Metabolites of Native Laying Hens

A. Jalalinasab¹, A. Nobakht²* and S. Razzaghzadeh¹

¹ Agriculture Jihad Organization of Urmia, Urmia, Iran
² Department of Animal Science, Maragheh Branch, Islamic Azad University, Maragheh, Iran

Received on: 12 Jul 2013
Revised on: 11 Aug 2013
Accepted on: 15 Aug 2013
Online Published on: Jun 2014

*Correspondence E-mail: anobakht20@iau-maragheh.ac.ir
© 2010 Copyright by Islamic Azad University, Rasht Branch, Rasht, Iran
Online version is available on: www.ijas.ir

ABSTRACT

In this experiment 180 Azerbaijan province native laying hens from 28 to 40 weeks were separated in 6 treatments and 3 replicates (10 birds per replicate) as a (2 × 3) factorial arrangement of treatments in a completely randomized design. Treatments included two levels of dried tomato pomace (DTP) (8 and 16%) and 3 types of using methods (unprocessed, alkali and acid processed). The results showed that different levels of DTP and processing methods significantly affected the performance, egg traits and blood parameters of native laying hens (P<0.05). Using 16% of DTP in contrary with 8%, without having any other adverse effects on feed conversion ratio and other production parameters, only reduced the eggs weight. In interaction between the levels of DTP and processing methods, alkali processing, improved the adverse effects of high level of DTP on eggs weight, while acid processing could not show this effect. DTP processing and levels, improved the egg yolk color index. Processing with acid increased the values of triglyceride and albumin in the hens’ blood. In 16% of DTP, more than triglyceride and albumin, the level of total protein in contrary with 8% increased. Interaction between DTP and processing methods showed that with 16% of DTP in alkali treating, the values of triglyceride and albumin in blood reduce, while the total protein increased. In acid treating, the percentages of heterophile and heterophile to lymphocyte ratio reduced, while the lymphocyte percentage increased. The overall results showed that in native laying hens, using dried tomato pomace up to 16% of their diets, not only did not have any adverse effects on their performance, egg traits and blood parameters, but also increases some of them, that these beneficial effects improved by alkali and acid processing methods.

KEY WORDS egg traits, native laying hens, performance, tomato pomace.

INTRODUCTION

Tomato (Lycopersicon ensulentum) is one of the most popular vegetable used as a salad in food preparations and also commercially in form of juice, soup, puree, ketchup or paste. During commercial processing of tomato, large amount of waste are produced at various stages. From 1000 kg of fresh tomatoes, 100 to 300 kg of wet tomato pulp is produced and can be sold as animal feedstuffs. Its nutritional value is highly dependant on the tomato cultivars, growing conditions, degree of drying and processing method (Persia et al. 2003). Wet tomato pulp can be further dried to approximately 900 g/kg DM and, because of its chemical composition, which can use in poultry industry. A number of studies have determined the feasibility of feeding tomato waste in poultry. Literature review demonstrated that inclusion of dried tomato pomace (DTP) in laying hens diet resulted in similar performance with hens fed with corn
soybean meal diet (Dotas et al. 1999) or increased egg production (EP) and egg mass (EM) at the levels up to 100 g/kg in diets of laying hens (Jafari et al. 2006). However, the inclusion of DTP at a higher level (150 g/kg of diet) decreased EP and EM and increased feed conversion ratio (FCR) (Jafari et al. 2006). Studies by Nobakht and Safamehr (2007) indicated that in laying hens feeding of DTP, increased feed intake (FI), EP, egg weight (EW), EM and eggshell weight (EST), whereas serum and egg yolk cholesterol content were not significantly affected. Some researchers found that supplementing laying hen diet with tomato pomace levels and processing problems could be reduced. In the current experiment the effectiveness of tomato pomace levels and processing methods on performance and blood biochemical constitute of laying hens were investigated.

MATERIALS AND METHODS

Birds and experimental design
In this experiment 180 Azerbaijan province native laying hens from 28 to 40 weeks of age in 6 treatments and 3 replicates (10 birds per replicate) as a (2 × 3) factorial arrangement of treatments were used in completely randomized design. Treatments included two levels of (DTP) (8 and 16%) and 3 kinds of using methods (unprocessed, alkali and acid processed). Wet tomato pomace was supplied from tomato ketchup factory, after drying, enough amounts of DTP treated with 0.0487 M of NaOH as alkali agent and 0.2% of chloride acid as acid agent. The compositions of different forms of DTP were similar to NRC measures, so NRC dates were used in rations formulation.

Diets preparation
The diets were formulated to meet the requirements of birds established by the NRC (1994) for semi heavy broiler breeder hens (Table 1). The lighting program for laying hens during the experimental period was 16 hours light and 8 hours darkness. Environmental temperature was controlled and was about 18 °C. Feed intake, feed conversion, egg production percentage, egg mass and egg weight were determined weekly. Mortality was recorded if it occurred. The collected eggs were classified as normal or damaged; the latter including fully cracked eggs (an egg with broken shell and destroyed membrane), hair cracked eggs (an egg with broken shell but intact membrane) and eggs without shells (an egg without shell but with intact membrane). For measuring the egg traits, at the end of the experiment, 3 eggs were collected from each replicate. Egg specific gravity was determined by placing them in salty water. Egg shells were cleaned and maintained at environmental temperature for 48 h until were dried, and then they were weighed. Then, their average was considered as the final thickness of an egg shell for each experimental unit. Color index of the yolk (Roche color index), yolk index, egg albumin index, Haugh units were also determined (Farkhoy et al. 1994).

Blood biochemical and immunity parameters
At the end of the experiment, 2 birds from each replicate were randomly chosen for blood collection and approximately 5 mL blood samples were collected from the brachial vein.
One mL of collected blood was transferred to ethylenediaminetetraacetic acid (EDTA) tubes in order to determine immunity parameters including red blood cells, hemoglobin, packed cell volume, white blood cells and lymphocytes (Gross and Siegel, 1983). The remaining 4 mL blood was centrifuged to obtain serum to determine the blood biochemical parameters including glucose, cholesterol, triglyceride, albumen, total protein, and uric acid. Kit package (Pars Azmoon Company; Tehran, Iran) was used to determine the blood biochemical parameters using Anision 300 auto analyzer system (Nazifi, 1997).

Statistical analysis
The data were subjected to one way analysis of variance procedures appropriate for a completely randomized design using the General Linear Model procedures of SAS (2005). Means were compared using the Duncan multiple range test. Statements of statistical significance are based on P<0.05.

RESULTS AND DISCUSSION

Performance
The effects of different levels of DTP and processing methods on the performance of native laying hens are summarized in Table 2.

Alkali and acid processing of DTP and different levels of DTP significantly affect the amount of egg weight in native laying hens (P<0.05).

Alkali processing, decreased the adverse effects of major amount of DTP in diets, so, the egg weight in group contained 16% alkali processed of DTP was similar with low level of DTP.

In acid processing, the heavy eggs were obtained with 8% of DTP. 16% of DTP in comparison with 8% reduced the egg weight. Treated and untreated DTP could not significantly affect the hens performance (P>0.05), but numerically improved it.

Egg traits
The effects of different levels of DTP and processing methods on the egg traits of native laying hens are shown in Table 3.

Interaction between DTP levels and processing methods significantly affect the egg color index in native laying hens (P<0.05). Alkali and acid processing of DTP in contrary with unprocessed DTP, improved the egg color index, also yolk color in group that contained 16% of DTP was more than group contained 8% of DTP.

Interaction between DTP levels and processing methods did not have any significant effects on the egg traits in native laying hens (P>0.05).

Table 1 The composition of basic diets

<table>
<thead>
<tr>
<th>Feeds ingredients</th>
<th>Untreated</th>
<th>Tomato pome (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>45.00</td>
<td>16.00</td>
</tr>
<tr>
<td>Wheat</td>
<td>19.40</td>
<td>17.90</td>
</tr>
<tr>
<td>Soybean meal</td>
<td>17.00</td>
<td>12.50</td>
</tr>
<tr>
<td>Tomato pome</td>
<td>8.00</td>
<td>16.00</td>
</tr>
<tr>
<td>Oyster shell</td>
<td>8.25</td>
<td>8.25</td>
</tr>
<tr>
<td>Dicalcium phosphate</td>
<td>1.40</td>
<td>1.40</td>
</tr>
<tr>
<td>Salt</td>
<td>0.30</td>
<td>0.30</td>
</tr>
<tr>
<td>Methionine</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>Lysine hydrochloride</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>Vitamin A, D, E, K, C</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>Vitamin premix1</td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>Mineral premix2</td>
<td>0.25</td>
<td>0.25</td>
</tr>
</tbody>
</table>

Calculated composition

| Metabolisable energy (kcal/kg) | 2670 | 2670 | 2670 | 2670 |
| Crude protein (%)              | 15.50 | 15.50 | 15.50 | 15.50 |
| Ca (%)                        | 3.61 | 3.61 | 3.61 | 3.61 |
| Available phosphorus (%)       | 0.31 | 0.31 | 0.31 | 0.31 |
| Sodium (%)                    | 0.40 | 0.40 | 0.40 | 0.40 |
| Crude fiber (%)               | 2.93 | 2.93 | 2.93 | 2.93 |
| Lysine (%)                    | 0.93 | 0.93 | 0.93 | 0.93 |
| Methionine (%)                | 0.36 | 0.36 | 0.36 | 0.36 |
| Met + Cys (%)                 | 0.66 | 0.66 | 0.66 | 0.66 |

1 Vitamin premix per kg of diet: vitamin A (retinol): 8500000 IU; vitamin D₃ (cholecalciferol): 2500000 IU; vitamin E (tocopheryl acetate): 11000 IU; vitamin k₃: 2200 mg; Thiamine: 1477 mg; Riboflavin: 4000 mg; Panthothenic acid: 7840 mg; Pyridoxine: 7840 mg; Cyanocobalamine: 10 mg; Folic acid: 110 mg and Choline chloride: 400000 mg.

2 Mineral premix per kg of diet: Fe (FeSO₄ .7H₂O, 20.09% Fe): 75000 mg; Mn (MnSO₄ .H₂O, 32.49% Mn): 64.675 mg; Cu (CuSO₄ .5H₂O): 6000 mg; I (KI, 58% I): 867 mg and Se (NaSeO₃, 45.56% Se): 200 mg.
The effects of feeding different levels of DTP and treating methods on the performance of native laying hens are summarized in table 4. The effects of feeding different levels of DTP and treating methods on egg traits of native laying hens are shown in table 5. Blood biochemical parameters and blood cells are also discussed.

**Blood biochemical parameters**

The effects of different levels of DTP and processing methods on the blood biochemical parameters of native laying hens are summarized in table 4. Processing methods, DTP levels and interaction between them significantly affect some of the blood biochemical parameters in native laying hens (P<0.05). In the interaction between DTP and processing methods, in alkali and acid treating of 16% of DTP, the values of blood albumin and total protein increased.

This effect on blood triglyceride level was seen in acid treated in contrary with unprocessed DTP, alkali treated caused the blood values of triglyceride and albumin reduce, while these values by acid processing increased. With 16% of DTP the amount of blood total protein increase.

**Blood cells**

The effects of different levels of DTP and processing methods on the blood cells of native laying hens are shown in table 5.
Processing methods, levels of DTP and interaction between them, significantly affect the values of blood cells in native laying hens (P<0.05). In contrary to the control group, acid processing caused the heterophile and lymphocyte percentages increase and the ratio of heterophile to lymphocyte reduce. These kinds of results were obtained in the interaction between DTP levels and processing methods. So that the lowest percentage of heterophile, and the highest value of lymphocyte were observed in acid treated of DTP.

Tomato pomace using methods could not affect the production parameters of laying hens. These findings are in agreement with another experimental result (Safamehr et al. 2011). They showed that the enzyme addition into of DTP contained diets could not affect the performance of commercial laying hens. While another experimental result indicated that DTP processing increase it efficacy in broilers. These differences in the results may be related to hens breed, pro-

### Table 4

The effects of feeding different levels of DTP and treating methods on the blood biochemical parameters of native laying hens

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Triglyceride (g/dL)</th>
<th>Cholesterol (g/dL)</th>
<th>Albumin (mg/dL)</th>
<th>Total protein (mg/dL)</th>
<th>Glucose (g/dL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated</td>
<td>195.728b</td>
<td>145.768</td>
<td>2.303c</td>
<td>4.580</td>
<td>173.643</td>
</tr>
<tr>
<td>Alkali treated</td>
<td>160.635b</td>
<td>164.422</td>
<td>2.450^c</td>
<td>5.308</td>
<td>130.657</td>
</tr>
<tr>
<td>Acid treated</td>
<td>278.493a</td>
<td>212.435</td>
<td>2.735^a</td>
<td>5.295</td>
<td>156.762</td>
</tr>
<tr>
<td>SEM</td>
<td>24.473</td>
<td>19.210</td>
<td>0.076</td>
<td>0.076</td>
<td>0.061</td>
</tr>
<tr>
<td>P-value</td>
<td>0.015</td>
<td>0.077</td>
<td>0.005</td>
<td>0.076</td>
<td>0.061</td>
</tr>
</tbody>
</table>

---

### Table 5

The effects of feeding different levels of DTP and treating methods on the values of blood cells in native laying hens

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Heterophil (%)</th>
<th>Lymphocyte (%)</th>
<th>Heterophil / Lymphocyte</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated</td>
<td>18.500b</td>
<td>80.000b</td>
<td>0.231b</td>
</tr>
<tr>
<td>Alkali treated</td>
<td>22.000a</td>
<td>76.250c</td>
<td>0.288^c</td>
</tr>
<tr>
<td>Acid treated</td>
<td>12.500a</td>
<td>85.500a</td>
<td>0.146^c</td>
</tr>
<tr>
<td>SEM</td>
<td>1.599</td>
<td>1.622</td>
<td>1.612</td>
</tr>
<tr>
<td>P-value</td>
<td>0.004</td>
<td>0.006</td>
<td>0.005</td>
</tr>
</tbody>
</table>

---

**DTP:** dried tomato pomace.

**SEM:** standard error of the means.

The means within the same column with at least one common letter, do not have significant difference (P>0.05).

---

**DTP:** dried tomato pomace.

**SEM:** standard error of the means.

The means within the same column with at least one common letter, do not have significant difference (P>0.05).
duction level, processing methods and DTP levels in hens diets. It thought that as the production values in native laying hens in contrary with commercial hens is low and they have a developed digestive tract, so they can tolerate high levels of DTP in their diets and processing methods could not improve the efficacy of these high fibrous feeds. In contrary with 8%, using 16% of DTP caused the amount of egg weight significantly reduced. As in contrary with 8%, 16% of DTP contained major amount of crude fiber, so with a high level of DTP, considerable amount of crude fiber consumed by hens. In this condition, usually before supplying sufficient amounts of nutrients, digestive tract physically impacted. Some nutrients such as amino and fatty acids have positive effects on egg weight, by using high level of DTP, maybe these nutrients could not supply enough amounts so caused the amount of egg weight reduce. In contrary to the results of the present experiment, it was reported that using DTP in laying hens diets not only did not have reduced effect on egg weight, but also increase it (Nobakht and Safamher. 2007; Safamehr and et al. 2011). DTP contains 13% of Lysine more than soybean meal (Dotas et al. 1999). Lysine has demining effects on egg weight, such as previous experiments by using DTP in commercial laying hen diets, the egg weight increased. The difference in the results of this experiment with reported results may be related to hens breed, production period and tomato levels. In interaction effects, treated (especially alkali treated) caused the major amounts of essential nutrients release and absorb into blood so the egg weight increased. The beneficial effects of DTP processing on laying hens and broiler performance were reported (Squires et al. 1992; Jafari et al. 2006). In another experiment reported that enzymatic processing of DTP could not change the production performance of commercial laying hens. These differences in the results may be related to processing methods, the levels of DTP and hens breed. As DTP is a rich source of carotenoids and vitamin A, using high level of DTP caused high amounts of these compounds supply for egg formation. Transferring them to egg yolk increased its color index. The result of this experiment is not in agreement with other research results (Nobakht and Safamher, 2007; Mansoori et al. 2008; Safamehr et al. 2011). These differences may be related to tomato pomace levels and production status of hens. In interaction effects, may be acid processing caused the high levels of nutrients release, by increasing the nutrients absorption, the levels of triglyceride, albumin and total protein increased. The improving effects of tomato pomace processing on nutrients availability were reported in other experiments (Squires et al. 1992; Jafari et al. 2006). On the base of blood biochemical results (Table 4), processing methods caused the high levels of nutrients release and absorb into blood. As in this experiment the production parameters in acid processing method in contrary with alkali treating is low, so the lowest amounts of them transferred into eggs and major amounts remain in body and increased the blood levels of triglyceride and albumin. Similar results were obtained in using 16% of tomato pomace.

The result of this experiment is in agreement with other experimental results (Nobakht and Safamher, 2007; Rahmatnejad et al. 2009). In the current study, the blood levels of cholesterol and glucose did not change. It may relate to diets composition, level of tomato pomace and production status of native hens. Lycopene is a major red carotenoid present in tomatoes and exhibits cholesterol lowering effect in human beings (Gerster, 1997). Also, tomato’s pectin increases the activity of plasma lecithin cholesterol acyl transferase and significantly decreases the concentration of serum cholesterol in rats.

Decrease in the percentage of heterophile, the ratio of heterophile to lymphocyte and increase in the percent of blood lymphocyte (Table 5) can be a sign in improving of immune system (Sturkie 1995). As tomato pomace is a rich source of some immune modulating agents such as lycopene, floate, vitamin C, vitamin A, phenolics and flavonoids (Sahin et al. 2008). By acid treating of tomato pomace, maybe the blood levels of these compounds alleviate and increased immunity status. As the performance of hens in alkali treating of tomato pomace was high, so it thought that the major amounts of these substances has been transferred into eggs and could not effectively enhance the hen’s immune function.

CONCLUSION

The overall results showed that in native laying hens using dried tomato pomace up to 16% of their diets, not only did not have any adverse effects on their performance, egg traits and blood parameters, but also increases some of them, that this improvement can be enhanced by using alkali and acid processing methods.

ACKNOWLEDGEMENT

The authors would like to thank Native hen Research Center of Agriculture Jihad Organization of Urmia for corporation in this study.

REFERENCES


