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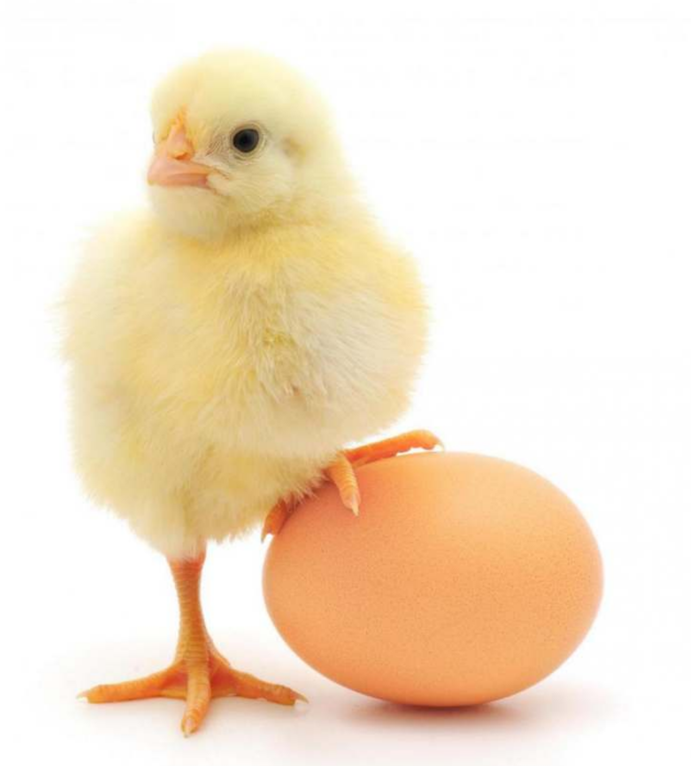

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The Use of Dried Tomato Pulp in Diets of Laying Hens

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Abstract: In an experiment with 288 laying hens from a commercial strain (Hy-line W36), the effect of partial and total replacement of soybean meal, corn grain, wheat grain and wheat bran with dried tomato pulp (DTP) on performance and egg quality was determined. In the 12 week experiment, hens (27 to 38 weeks of age) were allocated to four dietary treatments being: DTP0, DTP50, DTP100 and DTP150 of 72 birds each, and received a diet *ad libitum*. The diet for DTP0 treatment had no DTP (control), while those for treatments DTP50, DTP100 and DTP150 included 50, 100 and 150 kg/t of DTP, respectively. Inclusion of DTP at levels up to 100 kg/t in diets of laying hens increased egg production and egg mass by 2.7% and 4.1%, respectively, compared to the control and resulted in similar traits, relative to final BW, egg weight, daily feed consumption, egg shell weight, egg shell thickness, haugh units and yolk color. However, inclusion of DTP at higher level (150 kg/t of diet) decreased egg production and egg mass by 3.6% and 3.0%, respectively, and increased feed efficiency by 2.9% compared to the control. Thus, DTP can be used as an alternative feedstuff in laying hen diets, at inclusion levels up to 100 kg/t without negative effects on performance and egg quality.

Key words: Dried tomato pulp, egg quality, laying hens

Introduction

Wet tomato pulp is produced as a by-product of tomato juice manufacture (Cheeke, 1999) and contains 247 g/kg dry matter (DM, NRC, 2001). The wet tomato pulp, which amounts to 81000 tones annually in Iran, is considered waste and may cause serious environmental problems (Pirmohammadi *et al*., 2006). Increasing environmental concerns and legislation have promoted research into alternative methods of tomato waste disposal (Persia *et al*., 2003). From 1000 kg of fresh tomatoes, 100 to 300 kg wet tomato pulp are produced and normally disposed of being sold as animal feedstuffs (Ben-Gera and Kramer, 1969) and 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 possesses substantive nutritional value, can provide the poultry industry with an alternative feedstuff. Dried tomato pulp (DTP) contains 166 to 237 g/kg crude protein (CP), 57 to 122 g/kg crude fat and 300 to 378 g/kg crude fiber, according to NRC (1971) and Brodowski and Geisman (1980), and the limiting factors of DTP in poultry diets are its low energy and high fiber contents (Squires *et al*., 1992).

Abou Akkada *et al*. (1975), Tomczynski and Soska (1976) and Petrenko and Banina (1984) suggested that the tomato pulp and its various by products should be included at levels up to 50 g/kg in broiler chicken and laying hen diets, whilst Squires *et al*. (1992), Persia *et al*. (2003) and Al-Betawi (2005) suggested higher inclusion levels up to 150 g/kg in broiler chicken diets. Tomato meal was included at levels of 80 or 150 g/kg in diets fed to laying hens without negative effects on egg production and egg quality (Yannakopoulos *et al*., 1992). Moreover, DTP fed to laying hens at an inclusion level of 120 g/kg diet, resulted in similar egg production and feed consumption compared with hens fed a corn-soybean meal control diet (Dotas *et al*., 1999). However, there are no reported studies on the nutritional value of Iranian DTP for poultry. Thus, the objective of this study was to evaluate the use of Iranian DTP in diets of laying hens, relative to performance and egg quality, as well as the possibility of using DTP as partial replacement for other ingredients.

Materials and Methods

Dried tomato pulp: Wet tomato pulp was obtained from a commercial processor (Tatao Fruit Juice Factory, Urmia, Iran), then dried up at 65ºC, until a DM content of 900 g/kg was achieved (Table 1), and ground using a hammer mill.

Laying hens: Two hundred and eighty eight laying hens from a commercial strain (Hy-line W36, Hy-line Company, Urmia, Iran) were randomly allocated to four dietary treatments (DTP0, DTP50, DTP100 and DTP150) in a completely randomized design. All birds used in the experiment were cared for according to applicable recommendations of U.S. National Research Council (NRC, 1996). Hens of each treatment were divided into twelve subgroups (replicates) of 6 birds each, and accommodated to 12 floor pens/treatment. At the beginning of the experiment, hens of all treatments had similar body weight (BW, 1290 ± 28 g), egg production (0.89 ± 0.01 eggs/hen/day) and egg weight (50.54 ± 0.16 g). All 48 pens were identical and were equipped with similar troughs for diets and water. During the 12 week experimental period, from 27 to 38 week of age, all hens in the four treatments received four different diets (Table 2), according to nutrient requirements of laying hens as given by NRC (1994). The diet for DTP0 treatment had no DTP (control), while those for treatments DTP50, DTP100 and DTP150 included 50, 100 and 150 kg/t of DTP, respectively. All diets were isonitrogenous and isoenergetic, having the same level of the amino acids lysine, and methionine and cystine, according to NRC (1994) nutrient composition values.

During the experimental period, conventional management procedures were employed, natural and artificial light was provided for 16 h per day, ambient temperature was controlled and birds were fed and watered *ad libitum*. Hens' BW (g) was measured every four weeks on a pen basis. Mortality, feed consumption (DFC, g), egg production (eggs/hen/day), egg weight (g), egg mass (g/hen/day) and feed efficiency (kg feed/kg egg mass) were recorded daily. Furthermore, in 3 eggs per replicate collected randomly at the 4th, 8th and 12th week of the experimental period, egg quality was evaluated by measuring egg shell weight (after washing and drying overnight at 80°C, and then weighed with a digital balance), egg shell thickness (Lundholm, 1987), haugh units (Haugh, 1937) and yolk color (by using a Roche fan).

Chemical analyses: DTP used in the experiment was analyzed for DM by drying at 102°C for 16 h in a forced air oven, and for CP, crude fat, crude fiber, ash, calcium and phosphorus (Table 1) according to methods 976.06, 920.39, 978.10, 942.05, 968.08 and 965.17, respectively, of AOAC (1990).

Statistical analysis: Performance and egg quality of laying hens were statistically analyzed by one-way analysis of variance with the pen of hens being the experimental unit, while significant differences among treatment means were tested using the Duncan's test at the 5% probability level (Steel and Torrie, 1980). The statistical analysis was made with the help of the SAS Statistical Software Package (SAS, 1985).

Results

The results for performance and egg quality of laying hens are presented in Table 3. At the end of the experiment, final BW, DFC, egg weight, egg shell weight, egg shell thickness, haugh units and yolk color were similar among all treatments. However, egg production and egg mass were higher (P<0.05) in treatments DTP50 and DTP100 and lower (P<0.05) in treatment DTP150 compared to treatment DTP0. No differences were observed in hen egg production and egg mass between treatments DTP50 and DTP100. Additionally, feed efficiency was higher (P<0.05) in treatment DTP150 compared to treatments DTP0, DTP50 and DTP100. Finally, no deaths occurred during the experiment.

Table 1: Chemical composition (g/kg, as fed basis) of dried tomato pulp[1]

	Dried tomato pulp
Dry matter	900.0
Crude protein	207.7
Crude fat	73.1
Crude fiber	350.0
Nitrogen free extract	226.8
Ash	42.4
Metabolizable energy (kcal/kg)	1760
Calcium	5.0
Phosphorus	4.5

[1]Dried tomato pulp was analyzed for dry matter, crude protein, crude fat, crude fiber, ash, calcium and phosphorus according to AOAC (1990). Metabolizable energy value was taken from NRC (1971).

Discussion

The CP content of DTP (Table 1) used in this study was similar to that reported by Yannakopoulos *et al.* (1992), but higher than that reported by Squires *et al.* (1992) and Dotas *et al.* (1999), and the crude fat content in this study was lower than that reported by Squires *et al.* (1992), Yannakopoulos *et al.* (1992) and Dotas *et al.* (1999). These differences in CP and crude fat could be due to different tomato cultivars, growing conditions and processing methods (Persia *et al.*, 2003). Moreover, the calcium and phosphorus contents of our DTP were higher and similar, respectively, to those reported by NRC (2001).

Final BW and DFC were unaffected with increasing the DTP inclusion level in the diet. Additionally, egg production and egg mass increased with inclusion levels up to 100 g/kg diet, but decreased at an inclusion level of 150 g/kg diet. In agreement with our results, Tomczynski (1978) showed that hens fed on diets containing tomato skins up to 71.7 g/kg had higher egg production than hens fed on a control diet. In contrast, Dotas *et al.* (1999) reported that there were not any negative effects on egg production of hens fed on diets containing DTP at levels up to 120 g/kg, and Gregoriades *et al.* (1984) and Yannakopoulos *et al.* (1992) reported no significant differences in egg production of laying hens fed on diets containing up to 150 g/kg DTP compared to hens fed on a control diet. The inconsistency in egg production between the last three studies, that concern diets with 120 to 150 g

Table 2: Composition[1] of laying hen diets (as fed basis)

	Treatment[2]			
	DTP0	DTP50	DTP100	DTP150
Ingredient composition (kg/t)				
Corn grain, ground	607.14	600.62	608.61	555.40
Wheat grain, ground	20	20	0	0
Wheat bran	61	30	0	0
Soybean meal (440 g/kg CP)	150	136.7	128.9	118.1
Dried tomato pulp (208 g/kg CP)	0	50	100	150
Fish meal (642 g/kg CP)	30.9	30.9	30.9	30.9
Poultry fat	40	40	40	55
Oyster shell	30	30	30	30
L-Lysine monohydrochloride	0.5	1.1	0.9	0
DL-Methionine 990 g/kg	0.46	0.68	0.89	1
Limestone	48.3	48.1	47.8	47.6
Dicalcium phosphate	3.9	4.1	4.2	4.2
Salt	2.8	2.8	2.8	2.8
Vitamin premix[3]	2.5	2.5	2.5	2.5
Mineral premix[4]	2.5	2.5	2.5	2.5
Chemical composition[5] (g/kg)				
Metabolizable energy (kcal/kg)	2900	2900	2900	2900
Crude protein	150	150	150	150
Crude fat	65.5	67.9	70.3	86.4
Crude fiber	31.5	44.4	57.7	73.2
Calcium	32.5	32.5	32.5	32.5
Avail. Phosphorus	2.5	2.5	2.5	2.5
Sodium	1.5	1.5	1.5	1.5
Linoleic acid	15.1	15.6	16.3	16.3
Lysine	8.6	8.6	8.6	8.6
Methionine + cystine	5.8	5.8	5.8	5.8
Threonine	5.5	5.5	5.5	5.5
Tryptophan	1.8	1.8	1.7	1.7

[1]Dry matter content 900 g/kg. [2]DTP0 = control treatment, DTP50 = treatment with 50 kg/t dried tomato pulp, DTP100 = treatment with 100 kg/t dried tomato pulp, DTP150 = treatment with 150 kg/t dried tomato pulp. [3] Premix supplied per kg of diet: 9000 IU vitamin A, 1.78 mg vitamin B_1, 6.6 mg vitamin B_2, 30 mg niacin, 10 mg pantothenic acid, 3 mg vitamin B_6, 0.15 mg biotin, 1500 mg choline, 0.015 mg vitamin B_{12}, 2000 IU vitamin D, 18 IU vitamin E, 2 mg vitamin K_3. [4] Premix supplied per kg of diet: 10 mg Cu, 0.99 mg I, 50 mg Fe, 100 mg Mn, 0.08 mg Se, 100 mg Zn. [5]All values were calculated from NRC values (1994).

DTP/kg, and our study, that concern diet with 150 g DTP/kg, may be due to the lower fiber content of the DTP (130 to 270 g crude fiber/kg DTP) used in the experiments of these researchers than in our study (350 g crude fiber/kg DTP, Table 1). The high fiber content of a diet may decrease nutrient availability in poultry (Lesson and Summers, 2001), and therefore it's evident that the high fiber content of our DTP150 diet (73.2 g crude fiber/kg diet, Table 2) led to reduced egg production compared to the cited reports.

In our study, egg weight was not affected by the increasing level of DTP. This result can be attributed to the similar BW of hens, as well as the similar linoleic acid and CP contents in the diets of all treatments, and is in agreement with Tomczynski (1978) and Dotas *et al.* (1999). However, Yannakopoulos *et al.* (1992) found that tomato meal resulted in greater egg weight and suggested that this could be a consequence of its high lysine content. Moreover in our study, feed efficiency was similar among treatments with inclusion levels up to 100 g/kg DTP, but increased at an inclusion level of 150 g/kg DTP. In agreement with our results, Dotas *et al.* (1999) found that inclusion level up to 120 g/kg DTP had no significant difference on feed efficiency. In contrast, Yannakopoulos *et al.* (1992), who however used 52 week old hens and higher dietary DTP inclusion (150g/kg), found poorer feed efficiency compared to that found in our study with 27 to 38 week old hens. After the 40th week until the end of the laying period, egg production decreases in hens and concomitantly feed efficiency increases (Lesson and Summers, 1997), and thus the better feed efficiency in our study than that of Yannakopoulos *et al.* (1992) may be related to the lower age of our hens.

Our results that egg shell weight and egg shell thickness were not affected by the increasing level of DTP are in agreement with Yannakopoulos *et al.* (1992) and Dotas *et al.* (1999), and could be due to the similar calcium, phosphorus and vitamin D_3 contents in all treatments diets. In contrast, Gregoriades *et al.* (1984) found that the inclusion of DTP affected the shell thickness in layer diets. Moreover, there were no significant differences for haugh units among treatments. This result confirms the low effect that

Table 3: Performance and egg quality of laying hens

	Treatment[1]				SEM
	DTP0	DTP50	DTP100	DTP150	
Final body weight (g)	1367[a]	1380[a]	1380[a]	1365[a]	11.880
Daily feed consumption (g)	99.36[a]	101.53[a]	101.40[a]	98.98[a]	0.828
Egg production (eggs/hen/day)	0.908[b]	0.939[a]	0.927[a]	0.875[c]	0.431
Egg weight (g)	54.35[a]	55.09[a]	54.95[a]	54.64[a]	0.274
Egg mass (g/hen/day)	49.34[b]	51.75[a]	50.98[a]	47.85[c]	0.310
Feed efficiency (g feed/g egg mass)	2.013[b]	1.964[b]	1.990[b]	2.071[a]	0.018
Egg shell weight (g)	5.17[a]	5.17[a]	5.17[a]	5.16[a]	0.100
Egg shell thickness (mm)	0.352[a]	0.361[a]	0.362[a]	0.360[a]	0.001
Haugh units	94.53[a]	91.49[a]	93.17[a]	91.54[a]	1.020
Yolk color	4.625[a]	4.792[a]	4.750[a]	4.700[a]	0.120

[1]DTP0 = control treatment, DTP50 = treatment with 50 kg/t dried tomato pulp, DTP100 = treatment with 100 kg/t dried tomato pulp, DTP150 = treatment with 150 kg/t dried tomato pulp.

[a-c] Means within each row with different superscripts are significantly different.

nutrition exhibits on haugh units, something that has already been observed in previous studies (Lesson and Summers, 2001). Furthermore, there were no significant differences in yolk color among treatments with increasing levels of DTP, which is in agreement with Garcia and Gonzales (1984) and Persia *et al.* (2003). However, Yannakopoulos *et al.* (1992) found that yolk color was higher in eggs produced by hens fed on DTP diets.

Inclusion of DTP at levels up to 100 kg/t in diets of laying hens from 27 to 38 weeks of age increased egg production and egg mass by 2.7% and 4.1%, respectively, compared to the control and resulted in similar traits, relative to final BW, egg weight, DFC, egg shell weight, egg shell thickness, haugh units and yolk color. However, inclusion of DTP at higher level (150 kg/t of diet) decreased egg production and egg mass by 3.6% and 3.0%, respectively, and increased feed efficiency by 2.9% compared to the control. Thus, DTP can be used as an alternative feedstuff in laying hen diets, at inclusion levels up to 100 kg/t without negative effects on performance and egg quality.

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