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# EFFECT OF FEEDING ENSILED MIXED TOMATO AND APPLE POMACE ON PERFORMANCE OF HOLSTEIN DAIRY COWS

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## ABSTRACT

This study evaluated the effects of replacing alfalfa hay with ensiled mixed tomato and apple pomace (EMTAP) on performance of Holstein dairy cows. Six multiparous dairy cows in mid lactation were used in 3 × 3 Latin square design and fed alfalfa hay plus concentrate mixture with three levels of replacement with EMTAP (0, 15, 30%) for 63 days. The results showed that there were no significant differences between diets on milk composition percentage, but differences in milk production, DM intake, feed efficiency (FE) and some nutrient digestibility was significant ($P<0.05$) between diets. It was concluded that the nutritional value of tomato and apple pomace improved when used together (with ratio of 50:50), also EMTAP can be substituted efficiently up to 30% of diet without any adverse effect on performance of dairy cows.

**Key words:** tomato pomace; apple pomace; performance; dairy cow

## INTRODUCTION

Conventional and unconventional by-products from the food processing industry have been frequently included in livestock diets (Denek and Can, 2006). In recent years, because of economic considerations and waste technology, by-products are receiving increased attention by livestock producers and animal nutritionists (Grasser et al., 1995). Tomato and apple pomace are two alternative by-products obtained from tomato paste and apple juice industries, respectively. These by-products are produced in huge amounts annually. The chemical composition of final pomace is linked to the morphology of the original feed stock and the extraction technique used. Although tomato and apple pomace vary in nutrient density, effective processing can improve their nutritive value. According to NRC (2001), apple pomace (AP) is very low in protein (contains only 6.4% protein on DM basis) and it also serves as a useful energy source for ruminants (Oltjen et al., 1977). Studies showed that AP supplemented with natural protein was comparable to protein enriched corn silage (Rumsey, 1978; Bovard et al., 1977; Fontenot et al., 1977; Oltjen et al., 1977). In contrast, Elloitt et al. (1981) demonstrated that tomato pomace (TP) has the potential to be a good source of protein, but may be limited in energy due to the high fibre content.

Previous studies indicated that different results were obtained by various authors concerning feeding of TP and AP. Low protein concentration of AP (Alibes et al., 1984; NRC, 2001; Pirmohammadi et al., 2006), and high protein content of TP as supplemental protein (Del Valle et al., 2006; Fondevila et al., 1994; Gasa et al., 1989; Weiss et al., 1997) needed to recognize the ways to improve feeding value and usefulness of both by-products. It seems that their nutritional value could

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be increased, when used together in animal feeding. We previously observed that processed TP with AP (ratio of 50:50) had more palatability and digestibility in sheep than when processed with urea, wheat straw, NaCl and NaOH (unpublished data). Current effort is a first step to recognize the potential uses of these by-products with the main aim of evaluating different levels of EMTAP on performance of dairy cows.

## MATERIAL AND METHODS

### Tomato and apple pomace and silage preparation

Fresh experimental samples were collected from several main factories in Urmia city, Iran. The TP and AP were mixed together (ratio of 50:50) on DM basis and ensiled without any additive in a trench silo on a concrete floor. The mixed TP and AP were sealed for 55 days and then fed as TMR diets in three levels of replacement of alfalfa hay. Chemical composition of TP, AP and EMTAP (Table 1) was determined using the method suggested by AOAC (1990). Neutral detergent fibre (NDF) and acid detergent fibre (ADF) were determined using the method of Van Soest et al. (1991).

**Table 1: Chemical compositions of Tomato pomace, Apple pomace and mixed tomato and apple pomace ( on DM basis)**

| | TP | AP | EMTAP |
|---|---|---|---|
| Composition | | | |
| DM (% As-fed basis) | 26.0 | 30.7 | 27.4 |
| OM % | 87.8 | 97.4 | 92.5 |
| Crude protein% | 21.7 | 5.6 | 13.6 |
| Ether extract% | 13.4 | 4.7 | 9 |
| NDF% | 57.4 | 45.3 | 51.5 |
| ADF% | 50.7 | 38.0 | 44.4 |
| Calcium% | 0.31 | 0.11 | 0.20 |
| Phosphorus% | 0.45 | 0.12 | 0.28 |

TP, (Tomato pomace). AP, (Apple pomace). EMTAP, (Ensiled mixed tomato and apple pomace)

### Animals, housing and feeding

This experiment was carried out at the dairy barn of Urmia University in Iran. The effects of EMTAP on milk yield, milk composition and some nutrients digestibility were measured using six multiparous mid-lactating dairy cows (BW = 530 ± 18.10 kg; DIM = 91± 14 days). Cows were held in individual tie stalls and the normal herd management practices were followed during the experiment. The diets in the form of a TMR were given daily in two equal feeds at 08:00 and 20:00 h to provide approximately 10% refusal each day (as-fed basis). The refusals were removed and weighed before feed offered at 08:00 h. The body weight (BW) was recorded prior to morning of feeding on 2 consecutive days at the commencement and the finish of each period. The final BW for period 1 and 2 were used as the beginning BW for periods 2 and 3, respectively. The experimental periods lasted 21 d, including 14 d of adaptation and 1 wk of sampling and data collection. Daily feed intakes and milk production were recorded for individual cows throughout the experiment. The dietary treatments were formulated according to the NRC (2001) guidelines and contained three levels of replacement of EMTAP (DM basis) including diet 1 (control or 0%EMTAP), 2 (15%EMTAP) and 3 (30%EMTAP). Ingredients and chemical composition of the diets are shown in Table 2.

**Table 2: Ingredients and nutrient composition of experimental diets (DM basis)**

| | Diets (EMTAP levels) | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| Ingredient | 0%EMTAP | 15%EMTAP | 30%EMTAP |
| Alfalfa hay | 45.67 | 33.35 | 18.41 |
| EMTAP‡ | 0 | 15 | 30 |
| Soy bean meal | 10.25 | 10.23 | 9.92 |
| Barley | 37.96 | 37.99 | 38.2 |
| Fat (Oil plant) | 0 | 0.57 | 0.99 |
| Wheat bran | 5.4 | 2.09 | 1.54 |
| Caco3 | 0.22 | 0.27 | 0.44 |
| Premix† | 0.5 | 0.5 | 0.5 |
| Nutrient composition, % | (on DM basis) | | |
| DM | 98 | 78.3 | 63.1 |
| NEL ( Mcal/kg) | 1.54 | 1.58 | 1.62 |
| CP | 15.4 | 15.5 | 15.5 |
| NDF | 35.4 | 35.2 | 35.1 |
| ADF | 21.4 | 23.1 | 24.3 |
| Calcium | 0.6 | 0.6 | 0.5 |
| Phosphorus | 0.4 | 0.4 | 0.4 |
| Concentrate | 54.33 | 51.65 | 51.59 |
| Forage | 45.67 | 48.35 | 48.41 |

‡EMTAP, ensiled mixed tomato and apple pomace; DM, dry matter; NEL, net energy for lactation; CP, crude protein; NDF, neutral detergent fibre; ADF, acid detergent fibre. †Premix supplied (on a concentrate DM basis): 400.000 IU of vitamin A/kg, 100.000 IU of vitamin D3/kg, 100 mg of vitamin E/kg, 219 mg/kg of Mn, 69 mg/kg of Zn, 116 mg/kg of Fe, 23 mg/kg of Cu, 1.8 mg/kg of I, 0.6 mg/kg of Co, and 0.46 mg/kg of Se

**Sampling procedures and analytical methods**

The DM intake and refusals were measured daily and sub-sampled separately for each cow during the sampling periods. Total faeces were collected and sub-sampled (Sutton et al., 1997) from all animals for 3 d from d 4 to 6 of each sampling period. Daily samples of diets and refusals accompanied by faeces were dried at 60°C, grounded by a mill (1-mm screen), then analyzed for DM, OM, Kjeldahl N (AOAC, 1990) and NDF (Van Soest et al., 1991). Daily milk yields were recorded during the sampling period. On d 2 and 5 of each sampling period, milk samples were taken at morning and evening milking times and analyzed for fat, crude protein (CP), lactose and solids not fat (SNF) at the Ministry of Agriculture Jehad laboratory using milk analyzer instrument (Milko Scan™ model S50 Foss, type 75610). Rumen fluid was sampled on d 6 of each sampling period by a throat-oesophagus tube connected to vacuum pump, 3 h after morning feeding. Ruminal fluid was squeezed through two layers of cheesecloth and immediately analyzed for pH using a Schott Titrator Titroline easy pH meter.

**Experimental design and statistical analysis**

Six lactating dairy cows (BW = 530 ± 18.10 kg; DIM = 91± 14 days) were allotted to 3×3 Latin square design at three 21 d periods (adaptation, 14 d, and sample collection, 7 d) to evaluate the effects of EMTAP feeding on some nutrients' digestibility and performance in dairy cows. All data were statistically analyzed using the GLM procedure (SAS 1998, Inst. Inc., Cary, NC). Level of significance was $\alpha = 0.05$, and the Tukey test was used to test all pairwise comparisons among means. The model used for this study was:

$$\mathbf{Y_{ijk} = \mu + T_i + C_j + P_k + \varepsilon_{ijk}}$$

Where $Y_{ijk}$ is dependent variable, $\mu$ is the overall mean, $T_i$ is treatment effect, (i = 1, 2, 3); $C_j$ is cow effect, (j= 1 to 6); $P_k$ is period effect, (k= 1, 2, 3) and $\varepsilon_{ijk}$ is random residual error term.

## RESULTS AND DISCUSSION

**Feed intake and feed efficiency**

Mean daily DM intake and feed efficiency (FE) are shown in Table 3. The results indicated that diets containing EMTAP has higher DM intake and FE than for control diet. Higher digestibility and palatability along with lower DM content of EMTAP containing diets compared to control, may explain increased DM intake and FE of the animals fed EMTAP diets. It seemed that digestibility and palatability increased further when TP and AP were mixed together and ensiled, than when separately fed. Current results agreed with our previous findings in sheep (unpublished data). There is no available data on such mixed feeding of EMTAP to compare with, but Ghoreishi et al. (2007) reported that DM intake increased significantly when AP was fed to dairy cows. In contrast, Weiss et al. (1997), Belibasakis and Ambatzidiz (1995) and Fondevila et al. (1994) found that DM intake was not affected when TP was fed to lactating dairy cows.

**Table 3: DMI, milk production and composition of cows fed total mixed rations including 3 levels of ensiled mixed tomato and apple pomace (EMTAP)**

| Item | ‡Diets (EMTAP levels) | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | | |
| | 0%EMTAP | 15%EMTAP | 30%EMTAP | S.E.M. | P value |
| Change in BW ( kg/d) | 0.259 | 0.257 | 0.268 | 0.02 | 0.94 |
| DM intake ( kg/d) | 21.3$^{b}$ | 23.7$^{ab}$ | 24.5$^{a}$ | 0.68 | 0.02 |
| Feed efficiency (FE) | 0.93$^{a}$ | 0.92$^{ab}$ | 0.82$^{b}$ | 0.02 | 0.03 |
| Rumen pH | 6.55$^{a}$ | 6.31$^{b}$ | 6.01$^{c}$ | 0.04 | P<0.01 |
| **Milk production and composition** | | | | | |
| Milk yield kg/d | 19.9$^{a}$ | 21.9$^{b}$ | 20.4$^{ab}$ | 0.44 | 0.03 |
| 3.5 % FCM kg/d | 20.8 | 24.1 | 21.6 | 0.92 | 0.08 |
| Fat % | 3.82 | 4.17 | 3.91 | 0.14 | 0.24 |
| Protein % | 3.46 | 3.49 | 3.49 | 0.05 | 0.88 |
| SNF % | 12.7 | 13.12 | 12.75 | 0.20 | 0.32 |

‡Diets; 1= (control or 0% EMTAP); 2= (15% EMTAP); 3= (30% EMTAP); DM intake = dry matter intake (kg/d); FE = milk yield (kg/d) / dry matter intake (kg/d); 3.5% FCM= 0.4255 * amount of milk (kg/d) + 16.425 * milk fat (kg/d); SNF= solid not fat; S.E.M= standard error of mean

**Table 4: Nutrient digestibility of diets differing in ratio of EMTAP**

| Nutrients | Diets (EMTAP Levels) ‡ | | | S.E.M. | P value |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | | |
| | 0% EMTAP | 15% EMTAP | 30% EMTAP | | |
| DM | 64.24[b] | 66.59[a] | 66.84[a] | 0.6 | 0.03 |
| OM | 68.30[b] | 70.36[a] | 70.21[ab] | 0.5 | 0.04 |
| CP | 66.19 | 66.25 | 66.24 | 0.14 | 0.94 |
| NDF | 58.02 | 59.01 | 58.60 | 0.27 | 0.08 |

‡Diets; 1= (control or 0% EMTAP); 2= (15% EMTAP); 3= (30% EMTAP); S.E.M = standard error of means

**Milk production and compositions**

Mean daily milk yields, 3.5% fat-corrected milk (FCM) and ruminal pH were affected by the replacement of EMTAP in diet (Table 3). Cows fed EMTAP had higher ($p<0.05$) milk production and 3.5% fat-corrected milk than the control animals, but, differences between diets containing of EMTAP was not significant. In the present study EMTAP substitution may have caused better milk yield. It is believed that such mixed EMTAP as previously observed in our results made a progress in DM intake, nutrient digestibility and palatability of the diet, hence more milk production in diets containing EMTAP compared to control were noted. These findings are in accordance with those reported by Toyokawa et al. (1984), who stated that milk yield was increased when AP was mixed well with wheat bran, chopped alfalfa and milled rice bran (10% DM basis), ensiled and then fed to dairy cows. In contrast to present observations, Belibasakis and Ambatzidiz (1995), Belibasakis et al. (1990) and Weiss et al. (1997) reported that milk production and compositions are not affected when TP is fed to lactating cows.

The changes in mean daily milk composition percentage in response to EMTAP substitution in the present experiment were not significant ($p<0.05$). These findings are in agreement with other reports (Belibasakis and Ambatzidiz, 1995; Belibasakis et al., 1990; Weiss et al., 1997), indicating that fed TP had no effects on milk composition of dairy cows. As shown by other researchers, TP (7.0 %) and AP (15%) has considerable amount of pectin (Church, 1988; Del Valle et al., 2006; NRC, 2001) which rumen bacteria can use to produce acetate by fermentation and leading to proper condition for milk fat synthesis. Similar to our results, Rumsey (1978) reported that inclusion of 17% (DM basis) of AP in diet of fistulated steers led to slight reduction of rumen pH and increased acetate to propionate ratio. In the present study milk fat percentage was not affected but slightly increased when EMTAP was replaced in diet.

**Digestibility study**

Mean values of nutrient digestibility of diets are shown in Table 4. The results presented in Table 4 showed that for some nutrients digestibility tended to increase when EMTAP was substituted in diets ($P<0.05$). Chemical component of diet has a major effect on nutrient digestibility. Aregheore (1993) reported that nutritive value of the feedstuffs can be determined by their chemical compositions. It was showed (Ibrahem and Alwash, 1983; Gasa et al., 1989; Ojeda and Torrealba, 2001) that feeding of TP improved the nutritional value of the diet, due to more digestible levels of protein (61.2 %) it contains and ether extract (86.3 %). Rumsey (1978) reported that AP is equivalent to corn silage in total digestible nutrients content and rich in pectin, pentosans and ether extract. Generally, presence of more NFE, appreciable quantities of soluble carbohydrates (Vendruscolo et al., 2009; NRC, 2001; Hang and Woodams, 1986) and pectin (Kennedy et al., 1999; Del valle et al., 2006) in AP and TP, may lead to higher digestibility of DM and OM in diets containing EMTAP than control.

## CONCLUSION

The substitution of alfalfa hay by EMTAP in diet of lactating cows did not affect milk composition but significantly increased milk production, DM intake, feed efficiency and digestibility of some nutrients in diets. Finally, presented results demonstrate that using mixed TP and AP as compared to in individual form could improve their nutritive value and ensiled mixed tomato and apple pomace (EMTAP) can also be replaced efficiently up to 30% of dairy cows diet.

## REFERENCES

ALIBES, X. – MUFIOZ. F. – RODRIGUEZ, J. 1984. Feeding value of apple pomace silage for sheep. *Animal Feed Science and Technology,* vol. 11, 1984, p. 186-197.

AOAC .1990. Official Methods of Analysis, 15th ed. Association of Official Analytical Chemists, Arlington, VA, USA.

AREGHEORE, E. M. 1993. Chemical composition of some Zambia crop residue for ruminants nutrition. *Zambia Journal, Agricultural Science*, vol. 3, 1993, p. 11-16.

BELIBASAKIS, N. G. – AMBATZIDIZ, P. 1995. The effect of ensiled wet tomato pomace on milk production, milk composition and blood components of dairy cows. *Animal Feed Science and Technology*, vol. 60, 1995, p. 399-402.

BELIBASAKIS, N. G. 1990. The effects of dried tomato pomace on milk yield and its composition and on some blood plasma biochemical components in the cow. *World Review Animal Production*, vol. 25, 1990, p. 39-42.

BOVARD, K. P. – RUMSEY, T. S. – OLTJEN, R. R. – FONTENOT, J. P. – PRIODE, B. M. 1977. Supplementation of apple pomace with non protein nitrogen for gestating beef cows. II. Skeletal abnormalities of calves. *Journal of Animal Science*, 1977, vol. 45, p. 523-531.

CHURCH, D. C. 1988. The ruminant animal digestive physiology and nutrition Hardcover. 2nd edition, Prentice Hall : Englewood Cliffs, New Jersey. 1988. ISBN 0-8359-6782-4

DEL VALLE, M. – CAMARA. M. – TORIJA, M. E. 2006. Chemical characterization of tomato pomace. *Journal of the Science of Food and Agriculture*, vol. 86, 2006, p. 1232-1236.

DENEK, N. – CAN, A. 2006. Feeding value of wet tomato pomace ensiled with wheat straw and wheat grain for Awassi sheep. *Small Ruminant Research*, vol. 65, 2006, p. 260-265.

ELLOITT, J. – MULVIHILL, E. – DUMCAN, C. – FORSYTHE, R. – KRITCHEVSKY, D. 1981. Effect of tomato pomace and mixed vegetable pomace on serum and liver cholesterol in rats. *Journal of Nutrition*, vol. 111, 1981, p. 2203-2211.

FONDEVILA, M. – GUADA, J. A. – GASA, J. – CASTRILLO, C. 1994. Tomato pomace as a protein supplement for growing lambs. *Small Ruminant Research,* vol. 13, 1994, p. 117-126.

FONTENOT, J. P. – BOVARD, K. P. – OLTJEN R. R. – RUMSEY T. S. – PRIODE B. M. 1977. Supplementation of apple pomace with non protein nitrogen for gestating beef cows. I. Feed intake and performance. *Journal of Animal Science*, vol. 45, 1977, p. 513-522.

GASA, J. – CASTRILLO, C. – BAUCELLS, M. – GUADA, J. 1989. By-products from the canning industry as feedstuffs for ruminants: Digestibility and its prediction from chemical composition and laboratory bioassays. *Animal Feed Science and Technology*, vol. 25, 1989, p. 67-77.

GHOREISHI S. F. – PIRMOHAMMADI, R. – TEIMOURI YANSARI, A. 2007. Effects of ensiled apple pomace on milk yield, milk composition and DM intake of Holstein dairy cows. *Journal of Animal and Veterinary Advances,* vol. 6, 2007, p. 1074-1078.

GRASSER, L. A. – FADEL J. G. – GARNETT, I. – DEPETERS, E. J. 1995. Quantity and economic importance of nine selected by-products used in California dairy rations. *Jornal of Dairy Science*, vol. 78, 1995, p. 962-971.

HANG, Y. D. – WOODAMS, E. E. 1986. Solid state fermentation of apple pomace for citric acid production. *Mircen Journal*, vol. 2, 1986, p. 283-287.

IBRAHEM, H. – ALWASH, A. 1983. The effect of different ratios of tomato pomace and alfalfa hay in the ration on the digestion and performance of Awassi lambs. *World Review Animal Production*, vol. 19, p. 31-35.

KENNEDY, M. – LIST, D. – LU, Y. – FOO, L. Y. – NEWMAN, R. H. – SIMS, I. M. – BAIN, P. J. S. – HAMILTON, B. – FENTON, G. 1999. Apple pomace and products derived from apple pomace: uses, composition and analysis of plant waste materials. *Berlin Springer Verlag*, vol. 20, 1999, p. 75-119.

NOTIONAL RESEARCH COUNCIL 2001. Nutrient requirements of dairy cattle, 7th edition, National Academy Press, Washington DC, USA.

OJEDA, A. – TORREALBA, N. 2001. Chemical characterization and digestibility of tomato processing residues in sheep. *Cuban Journal of Agricultural Science*, vol. 35, 2001, p. 309-312.

OLTJEN, R. R. – RUMSEY, T. S. – FONTENOT, J. P. – BOVARD, K. P. – PRIODE, B. M. 1977. Supplementation of apple pomace with non protein nitrogen for gestating beef cows. III. Metabolic parameters. *Journal of Animal Science*, vol. 45, 1977, p. 532-542.

PIRMOHAMMADI, R. – ROUZBEHAN, Y. – REZAYAZDI, K. – ZAHEDIFAR, M. 2006. THE Chemical composition, digestibility and in sito degradability of dried and ensiled apple pomace and maize silage. *Small Ruminant Research*, vol. 66, 2006, p. 150-155.

RUMSEY, T. S. 1978. Ruminal fermentation products and plasma ammonia of fistulated steers fed apple pomace-urea diets. *Journal of Animal Science*, vol. 47, p. 967-976.

SAS, 1998. The SAS system for windows 6.03. SAS Institute Inc, Cary, North Carolina.

SUTTON, J. D. – ABDALLA, A. L. – PHIPPS, R. H. – CAMMELL, S. B. – HUMPHRIES, D. J. 1997. The effect of the replacement of grass silage by increasing proportions of urea-treated whole-crop wheat on food intake and apparent digestibility and milk production by dairy cows. *Journal of Animal Science*, vol. 65, 1997, p. 343-351.

TOYOKAWA, K. – SAITO, Z. – INOUE, T. – MIKAMI, S. – TAKAYASU, I. – TSUBOMATSU, K. 1984. The effects of apple pomace silage on the milk production and the reduction of the feed cost for lactating cows. *Bulletin of the Faculty of Agriculture-Hirosaki University*, vol. 41, p. 89-112.

VAN SOEST, P. J. – ROBERTSON, J. B. – LEWIS, B. A. 1991. Methods for dietary fiber, neutral detergent fiber and non-starch polysaccharides in relation to animal nutrition. *Journal of Dairy Science*, vol. 74, 1991, p. 3583-3597.

VENDRUSCOLO, F. – RIBEIRO, C. Da.S. – ESPOSITO, E. – NINOW, J. L. 2009. Protein enrichment of apple pomace and use in feed for Nile Tilapia. In: Applied Biochemistry and Biotechnology vol. 152, 2009, p. 74-87.

WEISS, W. P. – FROBOSE, D. I. – KOCH, M. E. 1997. Wet tomato pomace ensiled with corn plants for dairy cows. *Journal of Dairy Science*, vol. 80, 1997, p. 2896-2900.