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POMEGRANATEBY-PRODUCT (PUNICAGRANATUM L.)INANIMALNUTRITION: A REVIEW

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ABSTRACT

Pomegranate by-product can be used as a relatively good agro-industrial by-product for ruminant nutrition. Pomegranate fruit is consist of three parts, the seeds, the juice and the peels which include the husk and interior network membranes. using agro-industrial by-products is an alternative method for overcoming shortages and higher prices of conventional feed in ruminant nutrition. Many by-products have a substantial nutritive value as animal feed. Thus cereals can be largely replaced by these by-products and therefore competition between human and animal for nutrition is less. Furthermore, using these by-products like pomegranate by-product in animal nutrition can solve related environmental problems.

This review evaluates pomegranate by-product relative to their nutrient composition, content of secondary compounds, and theirimpact on animal performance.

KEY WORDS: Pomegranate peel, Pomegranate seed , by-product, secondary compound, agro-industrial

1. INTRODUCTION

Pomegranate (PunicagranatumL.) is an important fruit crop of tropical and subtropical regions of the world. It is extensively cultivated in Iran, Spain, Egypt, Russia, France, Argentina, China, Japan, USA and in India (Patil et al, 1996). Pomegranate fruit is consist of three parts: the seeds (about 3% of the weight of the fruit); the juice (about 30% of the fruit weight); and the peels which include the husk and interior network membranes (Prakash, C.V.S. and Prakash, I. 2011).

The is native to Iran with 7×105 tons produced annually (Khoshnamet al., 2007; Mansouriet al., 2011). Iran is also a major exporter of pomegranates, with an increase from 14,075 metric tons (2003) to 27,439 metric tons (2007) (FAO/WHO, 2009). Global production and consumption of pomegranate has greatly increased in recent years, at least partly due to recognition of the health-promoting potential of various components of this fruit to its human consumers (Aviram et al., 2008).This fruit is either consumed fresh or used in the juice industry.

Increasing agro-industrial units for producing pomegranate juice has led toto increased processing of by-products including peels and seeds (Shabtayet al., 2008). These processes have led to production of high quantities of pomegranate byproduct biomass.usually huge amounts of this byproduct produced in pomegranate producing regions and countries. Annual production of this by-product exceeds 120,000 metric tons in Iran (Mirzaei-Aghsaghali et al, 2011).fresh pomegranate biomass contains high levels of moisture and soluble sugars (Shabtay et al., 2008). If it can notused by farmers and industries as well as medical activities cause serious environmental problems.

There have been recent reports of lower methane emissions by ruminants consuming forages containing low or moderate vs. negligible levels of condensed tannins (**CT**), determined in vitro and in vivo with cattle (Roth et al., 2001; Woodward et al., 2001, 2002). Condensed tannins are found in a multitude of plants around the globe. Effects of CT in ruminants vary with the type of tannin or plant source.

The objective of this review is to summarize data on the nutrient profile of pomegranate by-product , and examine data on their nutritive value in animal diets.

2. Chemical composition andSecondary compounds of pomegranate by-product

2.1. Chemical Composition of Pomegranate Peel, Seed and Juice

There are some differences between chemical composition of pomegranate by-product in different studies.Ebrahimi et al (2011) reported that DM, CP, NDF, ADF, Ash and ADIN content of pomegranate peels were 90.53, 7.78, 32.44, 27.76, 9.21 and 0.94% respectively.According to Taher-Maddah et al, (2012) DM, CP, EE, Ash, NDF, ADF and NFCof dried pomegranate peels were 94.76, 3.37, 0.70, 4.00, 18.20, 12.60, 73.73% and ensiled were 48.36, 4.19, 0.50, 4.00, 13.60, 8.60, 77.71% respectively.

The result of Ullah et al (2012) analysis from pomegranate peel powder showed that the moisture content (04 ± 0.22%), ash(05 ± 0.14%), fat(9.4 ± 0.1%), acidity (4.86 ± 0.5%), crude fiber (21 ± 0.6%), Total sugar (31.38 ± 0.3%), Reducing Sugar (30.40 ± 0.11%), Non-Reducing sugar (0.98 ± 0.12%)

and Protein were (8.719± 0.10%). Shabtay et al,(2008) reported that DM, Ash, Protein, NDF, ADF, EE, lignin, CFand NFE content of pomegranate fresh peels were 18.7±0.5, 6.3±0.3, 5.8±0.3, 19.3±0.3, 15.9±0.5, 2.3±0.4, 4.5±0.2, 14.2±0.2 and 71.3±0.3 and Ensiledpomegranate peels were 14.5±0.3, 7.5±0.4, 9.2±0.7, 29.8±0.8, 26.5±1.3, 2.1±0.4, 8.9±0.9, 23.2±0.8 and 58.1±0.3% respectively. Mirzaei-Aghsaghali et al (2011) reported that DM, CP, EE, Ash, NDF, ADF and NFC content of pomegranate peels were 96.20, 3.60, 0.61, 5.4, 20.80, 15.10 and 69.57% .

According to Feizi et al, (2005a) the amount of DM, OM, CP, crude fiber (CF), EE, nitrogen free extract (NFE) of pomegranate seeds were 94.8, 96.8, 11.4, 38.9, 1, and 45.5, respectively; whereas Mirzaei-Aghsaghali et al (2011) reported that DM, CP, EE, NDF, ADF, Ash and NFC content of pomegranate seeds were 95.10, 15.40, 0.6, 68.00, 49.00, 2.4 and 13.50%, respectively.Taher-Maddah et al (2012) demonstrate that DM, CP, EE, Ash, NDF, ADF and NFC content of dried pomegranate seeds were 96.61, 8.07, 12.00, 2.8, 77.0, 55.0 and 0.13 and ensiled pomegranate seeds were 42.76, 11.65, 11.0, 2.05, 62.00, 45.00 and 13.30% respectively.Feyziet al (2010) indicated that adding urea to ensiled Pomegranate Seed (EPP) caused significant increases in pH, CP and decreased total extractable tannins (TET) ($P<0.0001$)

Oliviera et al (2010) determined that DM, OM, CP, Fat, NDF and NFC of pomegranate extract were 92.56± 0.26, 89.80±0.16, 1.11±0.06, 0.11±0.01, 0.60±0.53, 87.99±0.29% respectively.

Compounds isolated from pomegranate juicewas reported to be comprised of 85.4% water, 10.6%total sugars, 1.4% pectin, 0.2-1.0% polyphenols. Otherreported minor compounds include fatty acids, amino andorganic acids, indoleamines, sterols, triterpenoids and α-tocopherol. Anthocyanins, potent antioxidant flavonoids,provide pomegranate juice with its brilliant color, whichincreases in intensity during ripening (Hernandez, 1999), and declines afterpressing (Perez-Vicente, 2002 and Robert, 2010).

2.2. Secondary Compounds of Pomegranate By-Product

During growth and maturation period in plants some substances can be found in structure of them which they have essential role in plant fortune. These substances called plants secondary metabolites (Hagerman and Buther, 1981; Hassanpouret al, 2011). It has been suggested that accumulation of secondary compounds in plants is dependent upon photosynthetic capacity, season, rain and temperature (Mooney et al, 1975). One of the most important secondary metabolites of plants is polyphenols (e.g. tannins) (Hagerman and Buther, 1981; ChaichiSemsariet al,2011; Hassanpouret al, 2011; Maheri-sis et al, 2011). A great deal of research with tannins has followed anapproach that looks at biological relationships: taxonomy, phylogeny, biosynthesis, etc.

Tannins are phenolic plant secondary compounds and are high molecular weight phenlolic compound wich are present in many plants, including pomegranate (punicagranatum L.) fruit and by-product. Health benefits of pomegranate peel (antioxidant, antimicrobial, anti inflammatory, anticancer and other biological activities), recently reviewed by Prakash and Prakash(Prakash and Prakash, 2011). Presence of chemical compounds such as Hydroxybenzoic acids (Gallic acid, Ellagic acid), Hydroxycinnamic acids (Caffeic acid, Chlorogenic acid, p-Coumaric acid), Cyclitol carboxylic acids (Qunic acid), Flavon-3-ols/Flavonoids and their glycosides (Catechin, Epicatechin, Epigallocatechin-3-gallate, Quercetin, Kaempferol, Luteolin, Rutin,

Kaempferol-3-O-glycoside, Kaempferol-3-O-rhamnoglycoside, Naringin), Anthocyanins (Cyanidin, Pelarginidin, Delphinidin), Ellagitannins (Punicallin, Punicalagin, Corilagin, Casuarinin, Gallagyldilacton, Pedunculagin, Tellimagrandin, Granatin A, Granatin B) and Alkaloids (Pelleteriene); (Prakash and Prakash, 2011), in particulate tannins (Hassanpour et al, 2011) can be the main reasons of its bioactive functions.

Pomegranate seeds constitute about 3% of the weight of the fresh fruit. The major chemical components of pomegranate seeds are: 1) Hydroxybenzoic acids: Ellagic acid, 3,3'-Di-O-methylellagic acid, 3,3'.4'-Tri-O-methylellagic acid; 2) Conjugated fatty acids: Punicic acid (cis-9, trans- 11, cis-13 octadecatrienoic acid); 3) Non-Conjugated fatty acids: Linoleic acid, Oleic acid, Palmitic acid, Stearic acid; 4) Sterols: Stigmasterol, β-Sitosterol, Daucosterol, Camesterol, Cholesterol, 17-α-Estradiol, Estrone, Testosterone, Estriol; 5) Tocopherols: γ-tocopherol; 6) Triterpenes: Ursolic acid, Oleanolic acid; 7) Isoflavones: Genistein, Daidzein; 8) Phenyl aliphatic glycosides/Lignins: Coniferyl-9-O-[β-Dapiofuranosyl (1→6)-O-β-D-glucopyranoside, Sinapyl-9-O-[β- D-apiofuranosyl (1→6)-O-β-D-glucopyranoside, Phenylethylrutinoside, Icariside D1 (Prakash and Prakash, 2011). Pomegranate seed oil comprises 12–20% of total seed weight. The oil consists of about 80% conjugated octadecatrienoic fatty acids, with a high content of cis 9, trans 11, cis 13 acid (i.e. punicic acid), synthesized from nonconjugatedoctadecadienoic fatty acid. Linoleic acid which is the most important essential fatty acid, constitute about 7% of pomegranate seed oil.The presence of these components in pomegranate seed, make it a functional food and is believed to be beneficial to health by acting as an antioxidant as well as having anti-cancer and anti-inflammatory properties (Lansky and Newman, 2007).

3. Biological Activity of the Pomegranate

Making of pomegranate juice results in the production of pomegranate extract that is a rich source of polyphenols, presumably with potential health benefits. Pomegranate juice contains more than 100 phytochemicals (Seeram et al., 2006), but pomegranate extracts, one of the by-products of extracting the juice from pomegranate, contain polyphenolic compounds, primarily punicalagin and ellagitannins, which have been shown to possess antimicrobial, antioxidant, antiinflammatory, antimitotic, and immunomodulatory properties both in vivo and in vitro (Adams et al., 2006; Jayaprakasha et al., 2006; Rosenblat and Aviram, 2006). Recent studies (Li et al., 2006; Tzulker et al., 2007) demonstrated higher antioxidant capacity of the pomegranate by-product relative to the juice, mainly due to water-soluble polyphenols, anthocyanins and hydrolyzable tannins (Gil et al., 2000; Tzulker et al., 2007). In rats induced to have diarrhea by oral administration of castor oil, feeding extract from pomegranate seeds decreased defecation and gastrointestinal motility, presumably by reducing fluid pooling into the intestine (Das et al., 1999). In addition, the antimicrobial properties of pomegranate extract might directly reduce gastrointestinal infections, which in turn could reduce the risk of diarrhea.

While detailed knowledge of relationships of the chemical contents of pomegranates and their pharmacologicendpoints has yet to be obtained, a very significant progress has been made over the past 10 years toward a much more comprehensive understanding of some of the important pharmacologic components of pomegranate. Pomegranate peel and seed also attractsattention due to its apparent wound-healing properties (Chidambara et al, 2004),immunomodulatory activity (Gracious et al, 2001), antibacterial activity (Navarro et al, 1996), andantiatherosclerotic and antioxidative capacities (Tzulker et al, 2007).

All in all Extracts of the juice, bark, leaves, immature fruit, and fruit rinds have all been noted to have some medical significance, most notably antioxidant activity, antibacterial properties, uses in diabetes, heart disease and cancer. Although pomegranate's wideranging therapeutic benefits may be attributable to several mechanisms, most research has focused on its antioxidant, anticarcinogenic, antibacterial/antimicrobial and anti-inflammatory properties.

3.1. The Antioxidant Activity

The antioxidant activity of pomegranate components has been the subject to many studies (Naveena et al, 2008), most conducted in vitro and in vivo. All these activities may be related to the diverse phenolic compounds present in pomegranate, including the isomers of punicalagin, tannin derivatives, and anthocyanins (delphinidin, cyanidin and pelargonidin 3- glucosides and 3,5-diglucosides).these compounds are known for their properties to scavenge free radicals and to inhibit lipid oxidation in vitro (Gil et al, 2000).However, Tzulker et al (2007) suggested that punicalagin originating from the peels is one of the major phytochemicals contributing to the total antioxidant capacity of pomegranate juice, whilst anthocyanins play only a minor role in this activity. The effect of variety of pomegranate cultivars from Iran, Georgia and Turkey on antioxidant activity also target of study of some authors (Borochov-Neori,2009&Mousavinejad, 2009 andPande, 2009). All authors reported considerable variation in some of the chemical composition profile (lipids, phenols, organic acids, vitamins, sugars) and antioxidant properties of pomegranate samples, independent on the antioxidant method performed.

In the animal nutrition Shabtay et al, 2012 reported that Mid lactation Holstein cows fed up to 40 g/kgconcentrated pomegranate extract(CPE) may be more resistant to clinical mastitis, as only supplementation of CPE at 40 g/kg, reduced SCC level and proportion of cows with high SCC (i.e., >200,000/ml milk). They also (2008) reported that Dietary supplementation with fresh pomegranate peels promoted significant increases in R-tocopherol concentration in the plasma of bull calves. All in all, the nutritive value and the antioxidant capacity of pomegranate peel turn it into a favorable health-promoting constituent of feedlot beef cattle diet.

3.2. Antimicrobial/Antibacterial Activity

The antibacterial and antimicrobial properties of P.granatum have been studied extensively by various scientistsall over the world. Extracts from the plant have been found to work against methicillin-sensitive Staphylococcus aureus (MSSA), methicillin-resistant (MRSA) Staphylococcus aureus, Escherichia coli O157:H7, Salmonella typhi, and some streptococci strains (Braga et al,2005, Machado et al, 2003, Neurath et al,2005, Rani and Khullar, 2004). Thus, alternative medications that incorporate P. granatum have potential usefulness against bacterial infections. The antibacterial and antimicrobial attributes of P. granatum may have applicability to the dental field. P. granatumphytotherapeuticals was tested against the streptococci strains Staphylococcus mutans, Streptococcus mitis and Candida albicans. It was reported that both fermented andnonfermented pomegranate juices exhibited a potent and widespectrum antibacterial effect, with the highest activity against Pseudomonas aeruginosa(Fazeli et al, 2011). Haidari et al(2009) reported that the punicalagin present in the pomegranate extract had virucidal capability and inhibited influenza virus RNA proliferation independent on thevirucidal effect.Kannat et al (2010) reported that addition of PE to popular chicken meat products enhanced itsshelf life by 2-3 week during storage at chilled conditions. Sagdic et al (2010) reported that pomegranateseeds were extracted by methanol, ethanol and water were tested

for antioxidant and antiradical potential andantimicrobial activities against total fifteen microorganisms including thirteen bacteria and two yeasts.Ullah et al (2012) reported that Among the selected bacterial and fungal cultures, the highest antibacterial activity was recorded against Klebsillapneumoniaeand among fungi high activity against Aspergillusparasiticuswas recorded. The peel extract were shown no activities against Salmonella typhi, Bacillus cereus and Aspergillusflavus. Recently Jami et al (2012) reported that Supplementation of pomegranate-peel extract(CPE) significantly affected the abundance of methanogenicarchaea and specific ruminal bacterial species related to cellulolytic activities. Furthermore, CPE supplementation had a significant dose-dependent effect on the whole ruminal bacterial community.

3.3. Anti-inflammatory activity

Oliveira et al (2010) determined thatFeeding pomegranate extract did not influence concentrations of metabolites in plasma, fecal and attitude scores of calves, and neutrophil phagocytic and killing activities. Yet, calves fed pomegranate extract had blood mononuclear cells that produced more lymphocyte-derived cytokines in vitro and responded with increased titers against antigen vaccination. These data indicate that despite inhibitory effects on grain intake and fat and protein digestion when pomegranate extract was top-dressed onto the grain, itsphytochemical content influenced lymphocyte function.Wang Zhisheng and DONG Lifeng(2011) showed that pomegranate peel polyphenols extract (PPPE) supplementation can effectively relieve a in vitro subacuteruminal acidosis (SARA) and the 4.5% supplemental level had a better effect.

4. Nutritive value and effect of Pomegranate by-product on in vitro parameters

4.1. NutritiveValue ofPomegranteBy-Products

Ruminants, especially, have the unique capacity to utilize fibre, because of their rumenmicrobes. This means that cereals can be largely replaced by these by-products. Consequently the competition between human and animal nutrition can be decreased. In vivo, in situ and in vitro methods have been used to evaluate the nutritive value of feedstuffs. The in vitro gas production technique has proven to be a potentially useful technique to evaluate the nutritive value of feedstuffs, since it gives an estimate of the potential rate and extent of nutrient fermentation in the rumen. However, this technique is measuring gas produced by the fermentation of energy containing components in feeds, and not only that of protein (Mirzaei-Aghsaghali et al., 2008; Maheri-Sis et al., 2007). Shabtayet al (2008) demonstrated that pomegranate peel (PP) intake of up to 20% of the total feed intake does not possess deleterious or positive effects on fattening ration intake of feedlot calves. However, because of its palatability, in these amounts, total feed intake is increasing and its nutritional value consequently adds to the Average Daily Gain(ADG).

Shabtay et al (2008) demonstrated that dietary supplementation of pomegranate peels promotes an increase in feed intake, with a tendency to increased weight gain, in bull calves. In contrast, Oliveira et al (2010) found that feeding a pomegranate extract to young calves for the first 70 d of life suppressed intake of grain and whole tract digestibility of fat and crude protein, likely because of its high tannin content. Recently,Modarresi et al (2010)showed that use of pomegranate seed pulp (PSP) did not affect DMI and ADG of goats. Milk production tended to ($P< 0.05$) decrease with increasing level of PSP in diet. Milk fat concentration of goats fed diets with 6 and 12% PSP, increased by 8 and 15%, respectively but milk fat yield, milk

protein concentration and yield and milk SNF concentration and yield of goats was not affected by diets. Milk lactose concentration in goats were fed with 6 and 12% PSP, increased significantly compared with control group. Feeding PSP did not any significant effect on blood glucose, cholesterol, urea N, triglyceride and lipoproteins. It was concluded that pomegranate seed pulp as a cheep feedstuff source can be replaced with part of energy rich feedstuffs in goats.

Moreover, regarding the discrepancies between Shabtay et al (2008) and Oliveira et al's (2010) and Modarasi et al's (2011) findings, it appears that different pomegranate components may have different nutritive effects and influence milk production in different ways. Ebrahimi et al (1389) reported that dry matter disappearance of control and pomegranate treated with urea were 64.68 and 73.78 % at 96h respectively. The **a** fraction of control and treated were 34.58 and 35.68 respectively and **b** fraction of controland treated feeds are 30.78 and 37.83 respectively.Ebrahimi(2012) also investigated nutritive value of Pomegranate Pomace and showed that the gas production of pomegranate pomace at 48h were 128.75 ml/g DM.

Feyzi et al (2010) found thatin vitro gas production from the soluble and insoluble fractions (b), estimated in vitro organic matter digestibility and metabolizable energy were higher for EPP (Ensiled Pomegranate Peel) treated with 0% urea than other treatment (2.5, 5, and 7.5% of dry matte) and lower ($P<0.05$) for EPP treated with 7.5% urea. It seemed that there is a positive relationship between the tannins content and volume of the gas produced which was against the previous studies. This difference may be relates to the fact that different sources of tannins have different natures and different biological responses. Totally, this study showed that tannins have negative effect on in vitro rumen fermentation and PVP could show this effect.

Taher-Maddah et al (2012) determined the chemical composition and estimation of nutritive value of ensiled and dried pomegranate peel. They reported that although there is significant differences between gas production volume of dried and ensiled samples at early incubation times (2, 4, 6 and 8 h), the significant differences was not observed at further incubation timesThey suggested that both preservation methods (drying and ensiling) have similar effect on nutritive value of pomegranate peel for ruminants. Taher-Maddah et al (2012) also reported that ensiling lead to significant increase in gas production of pomegranate seeds (PS) at all incubation times. The gas volume at 24 h incubation, were 25.76 and 17.91 ml/200mg DM for ensiled and dried pomegranate seeds, respectively. The gas production rate (c) also was significantly higher for ensiled groups than dried (0.0930 vs. 0.0643 ml/h). Finally they reported that ensiled pomegranate seeds have a higher nutritive value than dried for ruminants under in vitro conditions. Recently Jami et al (2012) suggested thatpomegranate-peel extract (CPE) supplementation significantly affected the rumen bacterial communities, which in turn may be related to a beneficial effect on dairy cow performance.These changes were accompanied by a significant increase in digestibility of dry matter, crude protein, and neutral detergent fiber, as well as milk and energy-corrected milk yields in cows fed the 4% CPE supplement.

Accorrding to study of Mirzaei-Aghsaghali et al (2011) on conulated steers the amount of gas production for pomegranate seed (PS) and pomegranate peel (PP) at 2, 4, 6, 8, 12, 24, 48, 72 and 96 hours were measured. The results showed that gas volume at 24 h incubation (for 200 mg dry samples), were 22.90 and 47.42 ml/200mg DM for PS and PP, respectively. They indicated that pomegranate by-products (PS and PP) could be a fair to good food industrial by-product for ruminant nutrition, but it is required to more research.

4.2. Effect of Pomegranate By-Product on In Vitro Parameters

Authors demonstrated that the digestibility of by-products depends on the composition of the basic diet (Bampidis and Robinson, 2006, Denek and Can, 2006, Pirmohammadi,2007a, Pirmohammadi,2007b). A variable protein digestibility was also established by Stanhope et al (1980). a lot of by-products are characterized by wide variations in nutrient content. The potential value of by-products in animal feeding depends on their nutritive characteristics, as, the fibrousness, the protein content, organic-matter digestibility and energy value. Palatability is also an important feature. The utilization may not be detrimental for the animal. Apart from the presence of anti-nutritive factors, there are beneficial properties in some by products.

Recently Jami et al (2012) reported that Supplementation of pomegranate-peel extract (CPE) significantly affected the abundance of methanogenicarchaea and specific ruminal bacterial species related to cellulolytic activities and soluble sugar and lactic acid fermentation, as revealed by real-time PCR quantification. Furthermore, CPE supplementation had a significant dose-dependent effect on the whole ruminal bacterial community, as determined by automated ribosomal intergenic spacer analysis.

Taher-Maddah et al (2012) showed that the organic matter digestibility (OMD), metabolizable energy (ME), net energy for lactation (NEL) and short chain fatty acid (SCFA) of both treatments (Ensiled and dried pomegranate peel) were similar (57.29%, 8.61 MJ/kg DM, 4.67 MJ/kg DM, 1.03 mmol for dried samples and 57.18%, 8.58 MJ/kg DM, 4.83 MJ/kg DM, 1.02 mmol for ensiled samples, respectively). They also discovered that the organic matter digestibility (OMD), metabolizable energy (ME), net energy for lactation (NE_L) and short chain fatty acids (SCFA) of ensiled pomegranate seeds were significantly higher than that of dried samples (43.15%, 6.37 MJ/kg DM, 4.43 MJ/kg DM, 0.5553 mmol for ensiled samples vs. 34.62%, 5.10 MJ/kg DM, 3.56 MJ/kg DM, 0.3680 mmol for dried samples, respectively).The results of the this study based on chemical composition, OMD, ME, NEL and SCFA indicates that ensiling increases the nutritive value of pomegranate seeds and it is a better preservation method than drying for this by-product. Mirzaei-Aghsaghali et al (2011) reported that the in vitro organic matter digestibility (IVOMD), metabolizable energy (ME), short chain fatty acid (SCFA) and net energy for lactation (NE_l) content of PS were 423.4 g/kg DM, 6.20 MJ/kg DM, 0.504 mmol and 2.352 MJ/kg DM, while for PP were 590 g/kg DM, 8.85 MJ/kg DM, 1.048 mmol and 5.092 MJ/kg DM

5. Associative effect of pomegranate tannin

Tannin are high molecular weight phenlolic compound wich are present in many plants, including pomegranate (punicagranatum L.) by-product. Tannin are water-soluble polyphenolic polymers of relatively high molecular weight and have capacity to form complex mainly with protein , to a lesser extent with carbohydrate due to the presence of a large number of phenolic hydroxyl groups.phenolic compounds can denature enzyme (Furneri et al, 2002) but they can also bind to substrates such as mineral, vitamin, carbohydrates making them unavailable for microorganisms (Stern et al, 1996&Shahidi and Naczk, 2004) . furthermore phenols can be absorbed to the cell wall, resulting in a disruption of the membrane structure and function (Hugo and Bloomfield, 1971). decreased performance of sheep and goats, consuming diets rich in these anti-nutritional factors has been reported by many authors (Silanikove et al, 1996; Degen et al., 1998;Decandia et al., 2000). The potential use of tanniniferous shrubs in livestock feeding was thoroughly investigated and some reviews have discussed the negative and positive effects of tannins on ruminant nutrition and

performance (Makkar, 2003a; Min et al., 2003). althoughpolyphenolic compounds might improve animal health, they can also decrease proteolytic activity and, thus, protein digestion (Oliveira et al, 2010). Feiziet al (2005b) demonstrate the potential of pomegranate seed can be used in animal nutrition. They indicated that inclusion of pomegranate seed up to 25% of the diet had no negative effect on the nutrients intake and digestibility. Also they showed that pomegranate peel tannins have negative effect on in vitro rumen fermentation and increase the volume of gas produced with polyvinylpolypyrrolidone, revealed the inhibitory effects of tannins on fermentation (Feiziet al., 2005a. Modarresiet al., (2010) concluded that pomegranate seed pulp is an inexpensive source of feed and can be replaced with part of energy rich feed for goats, such as cereal grains.Mirzaei-Aghsaghaliet al. (2011) suggested that pomegranate seed can be used as a relatively good agro-industrial by-product for ruminant nutrition.

In spite of sufficient knowledge on biological effects of pomegranate peel in human and in some case in animal health; there is a little information on its nutritive value for ruminant animals (Feizi et al, 2005b &Mirzaei-Aghsaghali et al, 2011 & Oliveira et al, 2010 &Shabtay et al, 2008). Shabtay et al (2008) reported that using pomegranate peel up to 20% in feedlot calves diet, not only does not possess adverse effects on fattening performance but also because of its palatability, feed intake and consequently average daily gain were increased. They are suggested that tannins are considered to have both adverse and beneficial effects in ruminant animals. High concentrations of tannins may reduce feed intake, digestibility of protein and carbohydrates and animal performance via their negative effects on palatability and digestion. Low and moderate (2-4.5%) concentrations of condensed tannins in the diet improved production efficiency in ruminants, by increasing the flow of non-ammonia nitrogen and essential amino acids from the rumen.

6. CONCLUSIONS

High concentrations of tannins may reduce feed intake, digestibility of protein and carbohydrates and animal performance via their negative effects on palatability and digestion. Low and moderate (2-4.5%) concentrations of condensed tannins in the diet improved production efficiency in ruminants, by increasing the flow of non-ammonia nitrogen and essential amino acids from the rumen. the presence of these components in pomegranate pomegranate by-product such as Extracts of the juice, bark, leaves, immature fruit, and fruit rinds, make it a functional food and is believed to be beneficial to health by acting as an antioxidant as well as having anti-cancer and anti-inflammatory properties

Thus pomegranate by-products could be a fair to good food industrial by-product for ruminant nutrition, but it is required to more research.

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