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Review of Mango (Mangifera indica) Seed-Kernel Waste as a Diet for Poultry

Gebremedhn Beyene[1*] Alemu Araya[2]
1.College of Dry land Agriculture and Natural Resources, Department of Animal, Range land and Wildlife Sciences, Mekelle University, P.O.Box 231, Mekelle, Ethiopia
2.College of Dry land Agriculture and Natural Resources, Department of Crop and Horticultural Sciences, Mekelle University, P.O.Box 231, Mekelle, Ethiopia
*E-mail of the corresponding author: gebremedhnb@yahoo.com

Abstract
Mango consists of between 33-85% edible pulp, with 9-40% inedible kernel and 7-24% inedible peel. Because of this, a huge amount of waste is generated during industrial processing which are serious disposal problems. Therefore, using this huge amount of waste for animals feed could have an important element to fill the scarcity and competition problems of feed. However, most of these feeds contain anti-nutrients and toxic components such as saponins, lectins, tannins, trypsin inhibitors and cyanogenic glycosides which make them unsafe as protein and carbohydrate sources in livestock production. Boiling, drying, soaking, leaching and fermentation have been reported to be simple means of detoxifying these feed sources to reduce the presence of anti-nutrients and toxic components. If mango seed kernel waste is properly managed, it is considered as an asset, otherwise, if improperly handled it can be a threat to the environment.

Keywords: Anti-nutrients, Diet, Mango seed-kernel waste, Poultry

1. Introduction

Poultry production is gaining popularity in the developing countries due to its role in bridging the protein malnutrition, economic empowerment of the resource poor segment of the society and its ability to fit well in the farming systems commonly practiced. Bamgbose *et al.* (2004) reported that maize *(Zea mays)* as a major energy source in poultry feeds accounts for between 50 and 55% of most poultry feeds. It is equally used in human nutrition thus creating a stiff competition between man and livestock. The resulting effect is high cost translating into high feed cost. Some unconventional ingredients have been investigated as partial or total substitute for maize; they include Africa locust bean meal (*Parkia filicoidea*welw), avocado seed meal (*Persea americana*), bambara groundnut meal (*Voandzeia subterranean*), coffee pulp meal (*Coffee arabica*), and mango seed kernel meal (*Mangifera indica*) (Joseph and Abolaji 1997; Aregheore 1998; Kperegbeyi and Onwumere 2007). However, most of these feeds contain anti-nutrients and toxic components such as saponins, lectins, tannins, trypsin inhibitors and cyanogenic glycosides which make them unsafe as protein and carbohydrate sources in livestock production (Aregheore 1992).

Drying, soaking, leaching and fermentation have been reported to be simple means of detoxifying these feed sources to reduce the presence of anti-nutrients and toxic components (Aregheore 1998). Boiling has been reported to be effective in reducing the tannin content of mango kernel (Diarra and Usman 2008). Similarly, boiling reduced the tannin content of the kernel from 9.89 to 1.26%, representing about 87.26% reduction (Diarra *et al.* 2011). Diarra *et al.* (2010) reported no adverse effect of boiling on the crude protein, crude fibre, ether extract and nitrogen free-extract of the kernel.

Mango consists of between 33-85% edible pulp, with 9-40% inedible kernel and 7-24% inedible peel. Because of this, a huge amount of waste is generated during industrial processing which are serious disposal problems (Berardini *et al.* 2005). Therefore, using this huge amount of waste for animals feed could have an important element to fill the scarcity and competition problems of feed. For this purpose, the agro-industrial by-products contribute with the use of potentially polluting materials in animal feeding (Olivera *et al.* 2006). The kernel of mango seeds have been identified as a promising source of nutrients for farm animals and humans (Hutagalung 1981; Dhingra & Kapoor 1985); with a carbohydrate content of about 80% on dry matter (DM) basis (Dhingra & Kapoor 1985) mango seed kernels could be a useful energy source and would probably be a good substitute for maize which is the major source of energy in non-ruminant diets in several tropical countries. Therefore, the aim of this paper is to review the challenges and opportunities of mango seed-kernel waste as a poultry feed.

2. Distribution and Nutritive Value of Mango

The mango tree originated from South-East Asia is now widespread in tropical and subtropical areas between 30°N and 25°S, from sea level up to 1200 m (Orwa *et al.* 2009; Sukonthasing *et al.* 1991). Optimal growth conditions are average day temperature ranging from 24-30°C, annual rainfall between 750-2500 mm with a marked dry period for fruit induction, full-sun exposition on deep, well-drained and poor soils with pH ranging from 5.5 to 7.5. Mango trees are tolerant of drought or flooding conditions. In the subtropics, it can survive frost but young shoots and flowers are killed at temperatures ranging from 4°-12°C. Fruit production will be hampered if the frost comes too late in the season. Mango will not stand acidic or saline soils (Orwa *et al*. 2009; Sukonthasing *et al*. 1991).

Mango production in 2010 was 39 million t (including mangosteens and guava). 80% of the world production came from India (40%), China (11%), Thailand, Pakistan, Mexico, Indonesia, Brazil, the Philippines, Bangladesh and Nigeria. Most mangoes are consumed locally and only 3% of the production is exported, the main exporters being India and Mexico. Due to the increasing popularity of the fruit in Europe and North America, mango production doubled between 1990 and 2009 and exports saw an eight-fold increase during that period (FAO 2011; Jedele *et al*. 2003).

Mango is the most important tropical fruit crop after bananas and plantains (FAO 2011). The mango fruit is a large fleshy drupe, highly variable in size, shape, colour and taste and weighing up to 1 kg in some cultivars. Green when unripe, the fruit turns orange-reddish as it ripens after 3 to 6 months. The fruit consists of a woody endocarp (pit), a resinous edible mesocarp (flesh) and a thick exocarp (peel). The majority of mango production is consumed fresh and about 1-2% of the production is processed to make products such as juices, nectars, concentrates, jams, jelly powders, fruit bars, flakes and dried fruits (Berardini *et al*. 2005; Jedele *et al*. 2003). Mango varieties too fibrous or too soft for fresh consumption can be used for juice making (Hui 2007).

Mango processing yields about 40-50% of by-products, which can be used to feed livestock (de la Cruz Medina *et al*. 2002; Sruamsiri *et al*. 2009). These by-products are also potential sources of pectins and phenolic compounds (antioxydants) (Berardini *et al*. 2005). The mango kernel contains 7-12% of an oil rich in stearic (24-57%) and oleic (34-56%) acids that can be fractionated to give an olein with excellent emollient properties and a stearin that is one of the few fats that can replace cocoa butter in chocolate in certain countries (including the European Union) (Gunstone 2006; Schieber *et al*. 2001).Mango seed kernels (mango kernels)is the kernel inside the seed represents from 45% to 75% of the whole seed (Maisuthisakul *et al*. 2009). Mango seed kernels (MSK) contained carbohydrate (69.2 - 80%), protein (7.5 – 13%), fibre (2.0 – 4.6%), ash (2.2 – 2.6%), calcium (0.21%) and phosphorus (0.22%), which is comparable to that of maize, depending on the variety (Kiftewahid *et al*. 1982; Ravindran and Rajaguru 1985; Arogba 1989; Diarra *et al*. 2010). The kernel is also balanced in amino acids (Anon 1967).

3. Challenges and opportunities of mango seed-kernel waste

3.1. Environmental impact

It can be estimated that mango processing yields between 150,000 and 400,000 t of wastes worldwide, which may cause environmental problems in the vicinity of the plants. The use of mango wastes in livestock feeding is a way of reducing environmental concerns (Jedele *et al*. 2003; El-Kholy *et al*. 2008).

3.2. Anti-nutritional factors of mango

Mango kernels are fairly rich in tannins, which progressively lead to reduced growth rates and less efficient feed utilization when included as a major component in diets for pigs and poultry (Moore 2004). They also contain cyanogenic glucosides, (64 mg/kg DM), oxalates (42 mg/kg DM) and trypsin inhibitorsy (20 TIU/g DM) (Ravindran *et al*. 1996). These anti-nutrients chelate divalent ions like Ca^{2+}, Mg^{2+}, Fe^{2+}, and Zn^{2+} and also react with the charged groups of protein and polysaccharides thereby forming indigestible complexes while the toxic substances interfere with nutrient bioavailability and utilization (Haslam 1989; Reed 1995; Giner-Chavez 1996; Osagie 1998).

3.3. Processing strategies of mango

Several treatments (soaking, boiling, HCl or NaOH treatment, autoclaving or HCl followed by Ca(OH)2) may remove tannins and HCN but the more effective proved to be soaking as it removed 61% of the tannins and 84% of HCN (El Boushy *et al*. 2000). The nutritive value of mango kernels was improved by boiling, which restored growth depressed with untreated kernels (Diarra *et al*. 2008; Joseph *et al*. 1997). Boiling or autoclaving reduced anti-nutritional factors as tannins of trypsin inhibitors (Farag 2001). Soaking without boiling could also reduce anti-nutritional factors to some extent but was not efficient enough to restore growth up to the level of the control diet (without mango kernels) (Ravindran *et al*. 1996).

3.4. Mango seed-kernel waste as a poultry feed

Mango (*Mangifera indica*) belongs to the fruits family Anacardiaceae (El Boushy and Vander Poel 2000). The overall chemical composition of mango seed kernels make it suitable for poultry feeding, despite the presence of anti-nutritional factors. The metabolizable energy value is low in dried raw kernels (7.9 MJ/kg DM) but increased after boiling up to 10.3 MJ/kg DM (Ravindran *et al*. 1996).

In broiler chicks, the inclusion of raw mango seed kernel meal generally results in degraded performance. Inclusion rates as low as 5 to 10% depressed growth and feed intake in some experiments (El-Alaily *et al*. 1976; Diarra *et al*. 2008; Teguia 1995) while performance was maintained at 10% inclusion rate in another trial (Odunsi 2005). In older animals, raw kernel meal seems to be better consumed and performance can be maintained (Diarra *et al*. 2008; Odunsi *et al*. 1997). The recommendation for optimum growth is to use preferably boiled mango seed kernels and to keep the inclusion rate below 5% in chicks and below 10% in older animals. However, in slower growing animals higher inclusion levels could be tested. The incorporation of 5% raw mango seed kernel meal in layers decreased laying rate and increased weight loss in layers (Odunsi 2005).

Daily feed intake and feed conversion ratio were significantly ($P<0.05$) improved on the 60% mango kernel diet inclusion compared to the control diets (Diarra *et al*. 2010). Diarra *et al*. (2010) reported that there were no significant ($P>0.05$) treatment differences in final body weight and daily weight gain on the 60% mango kernel diet inclusion compared to the control diets. These authors were concluded also that up to 60% of the maize in broiler finisher diets can be replaced with boiled mango kernel meal without adverse effects on the growth, health and carcass parameters. Daily feed intake and feed conversion ratio were significantly ($P<0.05$) improved on the 60% mango kernel diet inclusion compared to the control diets (Diarra *et al*. 2010). Hence, Diarra *et al*. (2011) was concluded that boiled mango kernel meal can replace 50% of maize in the diets of broiler chicks and up to 75 % in the finisher diets. Similarly, Faniyi (1997) reported that broiler birds can utilize up to 30% level of mango seed kernel meal as an energy source during starter and finisher phases but that appropriate protein and metabolizable energy (ME) requirements of the birds should be taken care of in the diets.

4. Conclusion

Feeding of mango seed-kernel waste on poultry diets is so important on solving the problem of competition between poultries and humans for cereal grains as well as contributed in reducing the disposal problems of such wastes. Thus, further study on feeding of mango seed-kernel waste as an energy source for layers is required.

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