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The Nutritive Evaluation and Utilisation of *Moringa oleifera* Lam in Indigenous and Broiler Chicken Production: A Review

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ABSTRACT

There has been a decline in chicken production in most developing countries, yet poultry constitute an important pillar in HIV/AIDS alleviation and act as an income source plus food security in rural communities. The limited availability and high cost of stock feeds that have not increased concomitantly with producer prices are partly responsible for the decline. These limitations are especially important in rural communities because they are resource poor. Farmers therefore enlisted a priority research on alternative feed sources for poultry production since home-grown feeds available to the farmer can sometimes be limited. Maize and sorghum are usually the most abundant sources of grain available, which can supply adequate carbohydrate but not protein. Protein sources are expensive and hence unaffordable to the smallholder farmer. Small holder farmers have been using leaf meals as protein sources in order to alleviate feed limitations in poultry production. One such leaf meal is *Moringa oleifera* Lam (syns. *Moringa* pterygosperm, family Moringaceae). The uses of *Moringa oleifera* have attracted attention of researchers. Preliminary investigation showed that the plant has high biomass production. Its leaves are used as vegetables by humans in central Africa and have a good profile of amino acids that makes it a valuable source of livestock feed.

INTRODUCTION

Low protein consumption in the developing nations, as a result of poverty and over population has encouraged greater interest in the production of fast growing farm animals. Poultry production has been seen as a major strategy of bridging the animal protein gap to the teeming populace within short-run considerations (Gichohi and Maina, 1992). Poultry is popular because when compared with the beef industry for example, it enjoys a relative advantage of easy management, higher turnover, quick returns to capital investment and a wide acceptance of its products for human consumption (Haruna and Hamidu, 2004).

In Zimbabwe, poultry farming receive little attention from rural development agents as they pay much attention to cereals and large livestock, despite the fact that almost all farmers keep some flocks of chickens which constitute an important pillar in HIV/AIDS alleviation and act as an income source plus food security. According to Alders (2005) in Mozambique, village chickens provide a scarce animal protein in the form of meat and eggs and can be sold or bartered to meet essential family needs such as medicines, clothes and school fees. Alders (2005) reported that village chickens contribute to HIV/AIDS mitigation mainly through improved household food security and income generation. Eggs in particular offers important forms of nutrients, protein and vitamins (B_6 and B_{12}) and can be stored for some days under room temperature conditions. Livestock, especially poultry species, have shown to provide a practical and effective fast source of cash, quality nutrients in human diet, and are often essential for meeting important social and cultural needs and obligations (Mbugua, 1990).

Some major constraints in most developing countries are the irregular supply of conventional feedstuffs especially protein feedstuff and disproportionate high cost of feed (Kitalyi and Mayer, 1998). Effort is therefore being directed towards exploiting feed resources that are cheap, available and not in direct use by humans and other industrial users. Soya bean has traditionally been the ingredient of choice for the supply of protein in monogastric animal diets with inclusion levels from 21 to 23%. Soya bean plays an important role as a food ingredient to both humans and the food industries. However its availability in Zimbabwe and other countries in the tropics are affected by drought which causes relative scarcity of the ingredient and an increase in price invariably leading to an increase in feed costs particularly for poultry enterprises.

Similarly there has been a decline in indigenous and broiler chicken production among small holder farmers in Zimbabwe (Munangi, 2004). Numerous reasons have been given for this decline and again limited availability and high cost of commercial stock feeds that have not increased concomitantly with producer prices has been partly responsible. These limitations are especially important in rural communities and the smallholder resource poor -farming sector.

Farmers have enlisted priority research on alternative feed sources for poultry production since homegrown feeds available to the farmer is limited (Agricultural Research Council, 1999). Maize and sorghum are usually the most abundant sources of grain available, which can supply adequate carbohydrate but not protein. Protein sources are most required but, traditionally, they are found to be expensive and hence unaffordable to the small holder farmer. This calls for the need to research and develop innovative feeding technologies that can supply adequate and affordable protein feed that could lead to an increase in the production of indigenous and broiler chicken products. This review may provoke much research into the use of leaf meals in monogastric animals.

The use of leaf meals as protein sources in poultry

In tropical Africa, trees serve various traditional purposes such as source of food (leaves and fruits), timber, medicine, mulch, manure, and firewood and livestock fodder. However, little attention has been paid to tree cultivation for poultry feeding in Zimbabwe. In the mid-1980s agroforestry technology was introduced in Zimbabwe by the International Centre for Research in Agroforestry (ICRAF) with focus mainly on exotic browse species, Leucaena leucocephala, Sesbania sesban and Gliricidia sepium (Gutteridge and Shelton, 1993). Unfortunately, the adoption of these species by farmers has been faced with several challenges such as pests and diseases attack, presence of anti-nutritional factors and little extension support. There is therefore the need to discover and recommend novel tree species with exceptional agronomic qualities which will be readily adopted by farmers. One of such is *Moringa oleifera* Lam (syns. *Moringa* pterygosperm, family Moringaceae), a multipurpose tree. The multiple uses and potentials of *Moringa oleifera* have attracted scattered attention of researchers in recent times. Preliminary investigation showed that the plant grows fast, it has potentially high biomass production and exceptional biochemical properties, but there has been no systematic attempt to exploit *Moringa* either in terms of its agronomic or nutritive attributes (Akinbamijo et al., 2003). Its leaves and green fresh pods are used as vegetables by humans in central Africa and are rich in carotene and ascorbic acid with a good profile of amino acids (Makkar and Becker, 1996). It is also scarcely used as livestock feed and its twigs are reported to be very palatable to ruminants and have appreciable crude protein levels (Sutherland et al., 1996; Sarwatt et al., 2002). Tannins have been implicated as anti-nutritional factors found in tree leaf meals (Hove, 2000). However, this limitation has been found to be surmountable through processing, such as drying and determining optimum non-deleterious levels of inclusion.

Smallholder farmers have been using some home-grown and home-processed feeds in order to alleviate feed limitations in indigenous chicken production. However, there is no documented evidence based on systematic research on the nutritive value and levels of inclusion of such feeds as *Moringa oleifera* leaf meals in indigenous and commercial chicken diets. The nutritive value of a feed is a function of the feed intake, the efficiency of extraction of nutrients from the feed during digestion and the efficiency of utilisation of the extracted nutrients for growth (Mupangwa et al., 2000) or production of products such as eggs. There is therefore need for sustained assessment of the nutritive value of trees such as *Moringa oleifera* Lam in order to find out the best ways of utilising it as a protein source in diets of broiler and indigenous chickens. The following aspects need to be investigated about *Moringa oleifera;*

- Cultivation Practices and tree utilisation
- Genetic variability among tree provenances
- Field performance
- Prospects of feeding poultry.

Cultivation practices and utilisation of *Moringa oleifera*

Moringa oleifera distribution

Moringa species is mostly found in Africa, Madagascar, and parts of Asia, including Arabia and India. Nine species are found in the Horn of Africa. *Moringa oleifera* (Lam) was introduced to Africa from India, as an important multipurpose tree. The tree widely grows in the sub-Himalayan ranges of India, Sri Lanka, North Eastern and South Western Africa, Madagascar and Arabia. It has become naturalized in many locations in the tropics including Zimbabwe (Maroyi, 2006). Farmers consider *Moringa* as one of the most useful trees, as almost every part of the tree can be used for food, or have some other beneficial property as medicine or livestock feed. The provenances commonly grown by Zimbabwean smallholder farmers are Binga, Mutoko and Malawi. While there is evidence that the cultivation of *Moringa* tree in India dates back many thousands years, there is limited knowledge on the levels of diversity and relatedness of populations introduced to Zimbabwe, and their utilization as source of seed for planting. In Zimbabwe, *Moringa* is being used as one of the trees grown in combination with crops by smallholder farmers. It is a suitable tree for traditional agroforestry among small holder farmers because of its numerous benefits (Palada, 1996).

Smallholder farmers use the tree as an inter-crop in multi-storey system, hedge or decorative plant. *Moringa oleifera* has a wide range of adaptation from arid to humid climates with the prospects of being grown in a wide range of ecological zones.

Socio-Economic Importance

Moringa oleifera provides materials for utensils and construction, and contributes to improved diets and health, HIV/AIDS alleviation, food security and income generation (Scoones et al., 1992). The socio-economic value of biological diversity resides also in the indirect uses, such as the ecological services e.g. improvement of the quality of water and air, the supply of nitrogen through nitrogen rich biomass, the formation of soils and socio-cultural uses e.g. religious and cultural functions, recreational and aesthetic uses e.g. tourism.

The relative ease with which *Moringa oleifera* propagates, through both sexual and asexual and its low demand for soil nutrients and water after planting makes its production and management easy. Its introduction into a farm unit can be beneficial to both the owner of the farm and the surrounding eco-system (Foidl et al., 2001).

Genetic variability among tree provenances

Genetic characterisation

There is little information on the genetic base of *Moringa* provenances found in Southern Africa and their genetic relationships to the Indian populations. Such information facilitates tree improvement and propagation programmes, and conservation of the genetic resource. Molecular markers have proved to be powerful tools in the assessment of genetic variation between and within plant populations by analyzing large numbers of loci distributed throughout the genome (Powel et al., 1995). The technique of amplified fragment length polymorphism (AFLP) has been used in diverse studies in other species (Maugham et al., 1996). AFLP assays require no previous sequence knowledge and can detect 20 – 100 loci/assay (Maughan et al., 1996). There is the need to establish the genetic diversity of *Moringa* provenances within the tropics of Africa for sustained conservation purposes.

Tree morphology

Moringa oleifera is a fast growing deciduous tree with a trunk of up to 12 m tall and 30 cm in diameter. The branches give it an umbrella-shaped open crown (Fig. 1). It is a softwood tree with a corky and gummy bark. The leaves are alternate, oddly bi- or tri-pinnate compound, triangular in outline and 20– 70 cm long. Each pinnae has 3–9 pairs of 1–2 cm long ovate leaflets, soft dark green above and whitish below (Ramachandran et al., 1980). The white, fragrant flowers that are obliquely monosymmetric and papilionoid with five stamens are in axillary pendulous panicles 1.5–2 cm long from leaf corners. The fruit pods, called drumstick, are 15–45 cm long, 9-ribbed capsules opening by three valves to release the seeds (Morton, 1991). The seed hull is brownish semi-permeable and has three white wings that run from top to bottom. Each tree can produce 15 000 – 25 000 seeds per year. All parts of the Moringa tree are said to be edible. (Makkar and Becker, 1999).

Figure 1: Young Plantation of *Moringa oleifera*
(Source: Bindura University research unit, 2010)

Field performance

Growing Conditions

Moringa oleifera thrives well in both tropical and subtropical climates under hot, humid and wet conditions with rainfall in excess of 3000mm/annum. Moringa grows in a variety of soil conditions ranging from sandy or loamy to heavy clays. In Zimbabwe the tree thrives well in areas of marginal rainfall and poor soils around Binga and Mutoko areas. The tree tolerates mild frosts and establishes well in alkaline soils of up to pH 8 (Foidl et al., 2001)

The tree can be planted for forage production under intensive farming systems and can yield up to 3.0tonnes seed/ha. Makkar and Becker (1999) reported biomass production of up to 120 tons dry matter/ ha/yr in eight cuttings after planting 1million seeds/ha in trials held in Nicaragua. Pod bearing start 6-8 months after planting. However regular bearing starts after the second year and can go for up to 40 years. Owing to its drought tolerance, the tree is most suitable in those areas where the costs associated with production of commercial crops are high and can therefore be a valuable source of animal feed.

Prospects of feeding *M. oleifera* to poultry

General effect of leaf meals on chicken growth

In Zimbabwe small holder chicken farmers have and continue to use tree legume leaves (leaf meal) incorporated in diets to supply protein requirements of birds. Hove (2000) showed that *Acacia angustissima*, *Leucaena leucocephala*, and *Calliandira calothrysus*, among other leaf legumes, could be fed to monogastrics and sustain their growth and production requirements. The experiments involved use of tree leaf legumes as protein supplements that contributed 45% of the total protein requirements. The experiment concluded the need to investigate optimal inclusion levels of tree leaf meals in animal diets.

There is no information on the optimal inclusion level of *Moringa oleifera* in chicken diets. However there are some sketchy and a few related reports on studies of related focus. Chakoma et al. (2004) indicated that *Cajanus cajan*, *L. leucocephala*, and *C. calothrysus*, have been adapted well among the rural farmers of Zimbabwe. Farmers harvest leaves and stems of tree legumes and feed them dried to monogastrics, mixed with maize or sorghum. This was done with little confidence and knowledge on the part of the farmer. In view of this, Rukayinga (2004) confirmed that smallholder farmers in Chikwakwa, Zimbabwe, said that they appreciated the value of tree fodder but were not aware of the correct formulations which result in increased chicken production. Farmers also indicated that tree leaf legumes had reduced costs compared to purchased commercial feed, and that the animals fed on leaf meals did not lose body weight but maintained good body condition and produced tasty meat. It was further noted that farmers realised other benefits linked to good environmental management such as windbreaks, improved soil fertility and firewood plus fencing poles.

In other poultry nutrition studies, *Moringa oleifera* leaf meal (MOLM) was included as a feed ingredient in cassava chips (CC) based broiler diets on experimental basis. The study included seven isonitrogenous and isocaloric diets represented as treatments1 (maize meal based-control), 2, 3, 4 (20% CC and 0, 5, 10% MOLM) and 5, 6, 7 (30% CC and 0, 5, 10% MOLM) were fed to broiler chicks for 49 days in a completely randomized design. Measurements that were taken included weight, weight gains, final weight and feed consumed. The feed conversion ratio and feed cost per kilogram weight gain were calculated. Also obtained were the haematological parameters after the 49 day trial.

The results showed that, there was a reduction in performance with increasing inclusion level of MOLM beyond 5%. It was observed that birds on treatment 3 (20% CC, 5% MOLM) did not differ significantly (p>0.05) in terms of weight gain (2263.62-2428.26 gm), feed conversion ratio (2.57-2.81), final body weight at 8 weeks (2342.09-2501.24 gm) and feed cost per kilogram weight gain (979.38-1075.78 TSH) from those on the control, 20 and 30% diets (treatments 1, 2, 5). Highest feed consumption (6390.7gm) was recorded among birds on treatment 3 but did not significantly differ (p>0.05) from those on treatments 1, 2, 6 and 7(6002.7-6346.9 gm). From this study, it was recommended that broilers could be safely fed cassava- based diets containing MOLM at a maximum level of 5% without deleterious effects.

General effects of feeding leaf meals to pullets

Eighty- four Black Nera pullet chicks were weighed and randomly allotted to four dietary treatments which contained 0, 2, 4 and 6% *Centrosema pubescens* leaf meal (CLM) for treatments A,B,C and D, respectively in a completely randomized design. Treatment A served as control. Each treatment was replicated three times. There were seven birds per replicate. The experiment lasted for 6 weeks. At the end of the sixth week, the birds were mixed together and fed commercial feed for 4 weeks redistributed to four dietary treatments as in the pullet chicks, but in a completely randomized block design. Each phase was fed its own diet.

Results showed that feed intake was significantly (P<0.05) increased for the pullet chicks (PC) fed diets containing CLM, while dietary inclusion of CLM for the growing pullets (GP) resulted in significant reduction of feed intake with reference to control. Dietary inclusion of CLM (2-6%) (20-60g/kg) for pullet chicks significantly depressed the bird weight gain, total feed intake and food conversion ratio. Poor performance of these birds could be attributed to the presence of some anti-nutritional factors (Skerman et al., 1988; D'Mello, 1995), which resulted to poor feed digestibility and utilization (D'Mello, 1992). The results of this trial tended to agree with earlier observations that dietary inclusion of leaf meals of *L. leucocephala, G. sepium, C cajan, S. sesban and M. sculenta* depressed growth, feed intake, food conversion ratio (FCR) and growth rates of chicks at levels ranging from 75-100g/kg (D'Mello et al., 1987). However, in the present study 2-6% of CLM resulted to depression of growth of the pullet chicks. This result is contrary to that reported by Omeje et al. (1997) who concluded that 5.0-10.0% of CLM resulted to levation of weight gain and Nworgu and Fasogbon (2007) recommended 2.5-5.0% CLM for broiler chicks and broiler finishers. Daghir (1995) recommended 2% *L. leucocephala* leaf meal (LLM) for broiler starters and chicks starters and 3% LLM for broiler finishers, while Donko et al. (2002) recommended 25g/kg *Cnidoscolus aconitifolius* leaf meal for broiler chickens optimal performance. Dietary inclusion of 20-60g/kg CLM for Black Nera growing pullets significantly (P<0.05) and progressively reduced the feed intake due to the presence of anti-nutritional factors (Skerman et al., 1988; D'Mello, 1995). Similar observations were made by Udedibie and Opara (1998) when growing broilers and laying hens were fed diets containing graded leaves of *Alchornia cordifolia* and Odunsi et al. (2002) who fed laying hens *Gliricidia sepium* leaf meal (GLM). Odunsi et al. (2002) concluded that inclusion of GLM in layers diets significantly (P<0.05) reduced feed consumption in a linear fashion. Average daily feed intake in this study is similar to the result of Odunsi et al. (2002) (116.60-123.90g/bird), but lower than the submission of Udedibie and Opara (1998) (115-152.1g/bird), though higher than the result of Sobamiwa and Akinwale (1999) (67.3-68.0g/bird). The pullets fed diets containing 2-6% CLM had significant (P<0.05) elevated bird weight gain and food conversion ratio. Similar observation was made by Omeje et al. (1997) when they fed broiler chickens 5-10%. The variance in recommendations on non-deleterious inclusion level of leaf meals calls for further research in this area.

CONCLUSION

- Limited availability and high cost of commercial stock has been partly responsible for the decline in indigenous and broiler chicken production.
- There is the need to exploit feed resources that are cheap, available and not in direct competition with humans and other industrial users.
- Farmers harvest leaves and stems of tree legumes and feed them dried to monogastrics, mixed with maize or sorghum food.
- *Moringa* tree can be planted for forage production under intensive farming systems and can yield up to 3.0tonnes seed/ha.
- Use of leaf meals as poultry feed reduced cost of production as compared to purchased commercial feed.
- Animals fed on leaf meals with correct inclusion levels did not lose body weight but maintained good body condition and produced tasty meat.

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