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LAKHODI DAL (PULSES OF *LATHYRUS SATIVUS* L.): POSSIBLE ALTERNATIVE TO PROTEIN SOURCE IN LIVESTOCK FEED FOR SOCIOECONOMIC DEVELOPMENT

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ABSTRACT

Animal wealth of India is one of the largest in the world in terms of number of cattle and other livestock. Presently, India is self-sufficient in livestock feeds however, it is predicted that, in next 5 years Indian Feed Industry may reach $30 billion from $15 billion of current value. In order to balance the supply and demand, it is required to improve the productivity. Keeping this in mind, Indian Feed Industry is required to increase their capacities to fulfil the demand. With increased demand, search for alternative sources of essential nutrients such as protein source is imperative. To supplement grazing cattle, graziers use pulses and uses of pulses are increasing day by day. The best palatability and digestibility of pulses, which are also source of high protein and energy makes them most suitable feed for all forms of livestock. Lakhodi Dal (Pulses of *Lathyrus sativus* L., Fam. Fabaceae) is important foodstuffs in the tropical and subtropical countries, and used widely as protein rich diet. For more than 100 million people in drought-prone areas of Asia and Africa consider lakhodi as a traditional popular crop, because of its easy cultivation, its relative resistance to drought, flood, moderate salinity and insect attack and its good yield of tasty protein-rich seeds. Objectives of this review are to highlight the nutritional value of *Lathyrus sativus* L. and propose it as one of the potential source of protein to incorporate in livestock feed for socioeconomic development.

Keywords: *Lathyrus sativus,* Lakhodi, Khesri, Livestock, Animal feed

INTRODUCTION

Animal wealth of India is one of the largest in the world in terms of number of cattle, poultry, sheep & goats, camel horses and pets with growing aqua culture. As per the "*19th Livestock Census Report 2012*" published by Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture, Govt. of India, about 4.11% of total GDP contributed by Livestock

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sector at current prices during 2012-13. The total livestock population in 2011 was 1210.2 million as per the Office of Registrar General of India (ORGI). However, buffalo, cattle, donkeys, goat, horses and ponies, mithun, mules, pig, sheep and yak excluding stray dogs and stray cattle constituted 512.05 million as the livestock population in the country in 2012 (19th Livestock Census Report 2012). Since the liberalization, livestock industry has been influenced greatly by significant growth in per capita consumption of milk, eggs and broiler meat. Presently, India is self-sufficient in livestock feeds and does not depend on imports. As per the report- "The Indian Feed Industry – Revitalising Nutritional Security Knowledge" released during "Global Grain Food and Summit" held at Pune on June 20, 2016, the consumption of chicken, fish and meat along with the processed aqua, dairy and poultry products has increased greatly with changing lifestyle and increase in per capita income. This will ultimately result in higher feed requirement. The Indian feed industry mainly consist of dairy and poultry feed manufacturing where as there is no or negligible existence of beef and pork industry[2]. The Indian feed industry (aqua, meat and poultry) which was $15 billion in 2015 is growing at 8% of compound annual growth rate (CAGR). As per this report, in India, the increased demand for animal protein and dairy products will in turn increase the consumption of compound feed[1]. Presently, 7.5 million tonnes (mt) of cattle, 1 mt of aqua and 13 mt of poultry feed has been consumed with corn and soymeal (Puri N., 2015; Vaidya S. V., 2016; Information Brochure-Vibrant Gujarat 2017- 8th Global Summit, Jan. 2017). Considering the demand, it is expected that, in next 5 years Indian Feed Industry may reach $30 billion from $15 billion of current value. In order to balance the supply and demand, it is required to improve the productivity. One of the ways to achieve this is the good and quality

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feed[2]. Keeping this in mind, Indian Feed Industry is required to increase their capacities to fulfil the demand. Though, the Indian Feed Industry equipped with modern manufacturing technologies, sophisticated analytical procedures and formulation of least cost ration, the total production is only 5% of its actual potential with very less export (Vaidya S. V., 2016). In India, the feed ingredients are important and decided on the basis of particular species of the animal. In the research and development, Indian scientists have considered various aspects for the animal feed with majority of focus on use of by-products. Apart from this, the search for newer and newer ingredients was always there, mostly for the source of protein (Vaidya S. V., 2016).

In recent years, with increased demand of animal feed, a search for alternative sources of essential nutrients such as protein source was in progress. The Grains Research and Development Corporation and Pulse Australia Pty Ltd., Australia has published a report "*Pulses nutritional value and their role in the feed industry*" (Hawthorne W., 2006). This report highlighted various pulses, their nutritional potential, and market value and how they can be introduced as one of the sources of various nutritive factors. It also discussed regarding the formation of bridge between the growers and end-users of the produce. It is indispensable for the manufacturer to gain confidence of end-users to warrant a trustworthy, reliable and cost effective supply of stock feed with appropriate ingredients (Hawthorne W., 2006). Objectives of this review are to highlight the nutritional value of *Lathyrus sativus* L. (Fam. Fabaceae) commonly known as lakhodi, khesri in India and propose it as one of the potential source of protein to substitute other costly sources.

Pulses and beans: use in livestock feed

Pulses and beans are important foodstuffs in the dietaries of populations in the

tropical and subtropical countries. These are usually included under the term legumes and used widely as protein rich diet[6]. Considering this fact it is very essential to search for cheaper source of protein. In recent years, pulses have attracted the attention as a progressively demanding feed source with the diet comprising 10 to 20% of various pulses. Consistencies of supply and storage capacities also influence pulse usage. Peas are considered as the preferred pulse over other pulses in pig and poultry diets, on same cost, followed by lupins and faba beans. However, due to high protein content lupins are usually preferred in ruminant diets, and their reduced risk of non-starch polysaccharides and anti-nutritional factors. Other pulses like, chickpeas and lentils are greatly considered as prospective feed sources, but their use is somewhat limited because they have not been price competitive. Current usage of pulses in the stock feed industry is largely assessed by the local production, availability and the cost of competitive substitutes as protein source such as soybean meal. The major influential factors on cost of feed are the distinct geographic locations of production areas and the foremost local end-users and hence usage than simple preference based on nutritional value (Hawthorne W., 2006).

Actual usage of each pulse type varies enormously between regions and from year to year dependent upon availability, the mix of crop species being fed and changes in the prevailing market conditions for grains and livestock. A distinguishing feature of the feed industry is its preparedness to utilise a wide range of raw materials in response to market movements. The reliance upon any particular commodity from one year to the next is very less and therefore establishment of particular usage patterns or trend is difficult. End-users require sufficient quantities of product to start using that ingredient in their feed mix. Once the end-user get faith or committed to a product,

changes are unlikely for reasons of diet consistency and storage capacities. Corresponding to this is the ability for feed diets to change very rapidly in response to price movements. Now a days, computerised linear programming methods are used to provide highly specialised and most cost effective and highest nutritional combination of feedstuffs (Vaidya S. V., 2016; Patwardhan, V. N., 1962).

Thus, it is very important for the livestock industry to seek advice from the experts with regards to the quality and stability of the product with price factors when incorporating pulses into their diets. For the production of high quality and at the same time fast growing animals (beef cattle, lambs, pigs or poultry), producers must pay attention to the feed requirements of their animals. In order to maximize the milk production, dairy farmers are required to pay same attention on the quality of feed. Use of pulses can assist to achieve the animals' requirements for optimum growth and performance. The Indian aqua feed market is small, and may not reach significance however, international aquaculture feed market is constantly increasing. So, there may be potential for high value aqua feed containing pulses as one of the ingredients (Vaidya S. V., 2016; Patwardhan, V. N., 1962).

In order to supplement grazing cattle or sheep, graziers use pulses and uses of pulses are increasing day by day as it is being appreciated the value of pulses by growers and graziers in grazing and finishing systems. The best palatability and digestibility of pulses, which are also source of high protein and energy makes them most suitable feed for all forms of livestock. The amino acid profile of pulses are comparable to cereal grains with certain exemptions in amounts of some amino acids such as methionine and lysine are required to be fortified in feed to provide balanced diet[5]. The content of amino acids in the pulses varies as the protein content of pulses ranges from 18%

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to 36%. Similar variations in the levels of all other nutrients can be observed reliant to the variety of a particular pulse, location and growing conditions (Vaidya S. V., 2016; Patwardhan V. N., 1962; Edwards A.C., 2004; Petterson, Sipsas & Mackintosh, 1997).

Along with the naturally occurring chemical constituents, sometimes, the product may contaminate with chemicals or residues during processing, which should be absent in the feed as they are equally important as far as quality control is concerned. The security against residue is provided by Quality Assurance (QA) programs however prior to the rationing of formulation, feed should be analysed for quality check. The use of pulses in the feed is for supply of energy and protein to the diet. Price differentials of cereals, tallow or oil and alternative protein source along with the protein content greatly influence the value of pulses. So, there is wide spectrum of diverse material to compete with pulses in feed industry (Edwards A.C., 2004). On the contrary pulses can substitute the source of protein and other grains as they can supply both, protein and energy. However, the degree of substitution mostly based on prices of raw material. Being the commercial organizations, feed suppliers mainly focus on the cost of raw material and they usually set a limit for the addition of particular ingredients in the feed based on the profit calculations. So, the purpose of incorporation of pulses in addition to cereal grains in the feed for cattle and sheep is to balance the protein, energy and price, in case of ruminant diets, pulses can replace oilseeds whereas for the pig and poultry feed pulses can substitute both cereal grains and oilseeds (Edwards A.C., 2004).

Nutritionally, pulses fit very well into animal diets, although individual pulses have different applications for specific livestock groups. The decision to use pulses in the diet is usually an economic one. The main constraints limiting extended use of pulses in feed

diets are price, reliability of supply, storage capacity, and limits on inclusion rates. There are often price benefits to be gained from storing pulses on farm or in commercial storage facilities compared with selling straight off the harvester. There are also major benefits to both the producer and end-user if large parcels of pulses are regularly available. End-users are not always able to accumulate or store small individual quantities in order to aggregate them over time into parcels large enough to justify commencing use of that particular pulse in their diets. Consistent, regular pulse production and an appropriate infra-structure to store and aggregate pulses would be highly beneficial. The major pulses used in the feed industry are lupins, field peas and faba beans. Those utilised on a smaller scale include chickpeas, mung beans, lentils, navy beans and other culinary beans. The human consumption value of these crops normally far exceeds their stockfeed value. Generally, they only appear in the stockfeed market as downgraded material, screenings or oversupplies (Vaidya S. V., 2016; Patwardhan V. N., 1962; Edwards A.C., 2004; Petterson, Sipsas & Mackintosh, 1997).

Other pulses that may occasionally become available as ruminant feed grains include: grain vetches; or the newer, minor crops like narbon beans, dwarf chickling, grass pea or bitter vetch. Generally access to pulses for livestock feed is unrestricted, but there are exceptions. Access is limited mainly by commodity price, storage, transport costs if from a distant source, product quality issues concerning weed seeds and other contaminants, or occasional plant quarantine regulations (Vaidya S. V., 2016; Patwardhan V. N., 1962; Edwards A.C., 2004).

Pulses of *Lathyrus sativus* (Lakhodi dal) as a feed ingredient

Lakhodi Dal (Pulses of *Lathyrus sativus* L.) is important foodstuffs in the dietaries of populations in the tropical & subtropical countries. It is usually included under the term legumes

and used widely as protein rich diet. Since lakhodi is the cheapest food legume that most low-income families can afford, it is a common component of their traditional diet. Its seed also contain a high amount of free *l*-homoarginin, which acts as precursor of lycin in human nutrition. This legume is the only known dietary source for L-homoarginine and is preferred over arginine for nitric oxide (NO) generation. Homoarginine has beneficial effects on cardiovascular health and the example is that, it inhibits platelet aggregation. These seeds contain a neurotoxic non-protein amino acid that can cause irreversible spastic paraparesis (paralysis) of the legs when it is consumed as a major portion of the diet over a 3 to 4 month period (Moslehuddin, 1987; Bell, 1989; Khan et al., 1993; Abdelmoneim et al., 1997). Most of the anti-nutritional or toxic effects of legumes can be partially or wholly eliminated by proper methods of cooking. This accounts for the fact that heating serves to enhance the nutritive value of many legumes. Since the protein of most leguminous seeds is deficient in methionine, supplementation with this amino acid frequently effects a marked improvement in the biological value of the protein. For more than 100 million people in drought-prone areas of Asia and Africa consider lakhodi as a traditional popular crop, because of its easy cultivation, its relative resistance to drought, flood, moderate salinity and insect attack and its good yield of tasty protein-rich seeds. When other crops fail due to adverse conditions, lakhodi can be the only available food source for the poorest section of the population, and sometimes a survival food in times of drought-induced famine (Moslehuddin, 1987; Bell, 1989; Khan et al., 1993; Abdelmoneim et al., 1997).

Lathyrus sativus L. or grasspea (*Lakhodi* or *Khesari* in India and Bangladesh, *guaya* in Ethiopia, *san li dow* in China, *pois carré* in France) has been cultivated in South Asia and Ethiopia for over 2500 years (Bell, 1989). It is a drought tolerant crop

and used as food and feed-stuff in Africa and Asia (Khan et al., 1993; Abdelmoneim et al., 1997). Its ability to provide economic yield under adverse conditions like low rainfall has made it a popular crop in subsistence farming in many developing countries. Despite its tolerance to drought, *lakhodi* is not affected by excessive rainfall and can be grown on land subject to flooding (Sinha, 1980) with a large amount of protein per hectare (>0.5 t ha–1) (Bell, 1989). Lakhodi dal is processed by various methods for improvement of its nutritional value. This is achieved by soaking dal in water, steaming, autoclaving and fermenting results in the higher amino acid scores. The sulfur containing amino acids were the vitamin B 12 content of the dal (Moslehuddin,1987).

In Bangladesh, India, Nepal and Pakistan it is often broadcast into a standing rice crop where it flourishes on the residual moisture left after the rice has been harvested. The presence of neurotoxic amino acid, 3-N-oxalyl-L-2,3-diaminopropionic acid (β-ODAP), in lakhodi dal is the cause of an irreversible spastic paraparesis, neurolathyrism, after overconsumption. This is negative factor in an otherwise very tasty nutritious, easily cultivated and hardy food crop in Asia and Africa (Kuo et al., 2006).

According to studies conducted by some researchers (Rotter et al. 1991; Castell et al., 1994; Grela, 1998; Winiarska-Mieczan, 2002; Trombetta, 2006; Ramachandran & Ray, 2008; Winiarska-Mieczan, 2010), lakhodi to some extent can substitute soybean meal and rapeseed meal in animal feed. However, it has been advised that, lakhodi proportion should not exceed 15-20% (Bell, 1989) which may lead to reduction in production output at significant level (Winiarska-Mieczan, 2002). So, the aim of the present review is assess the possibility of usefulness of lakhodi in animal feed wholly or in part.

Key issue with introduction of lakhodi in feed industry

The state government of Maharashtra banned the sale of

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lakhodi dal in December 1961 following a directive from the central government that tribal farm labourers in Chhattisgarh suffered paralysis of the legs (lathyrism) after its large-scale consumption that famine year (Pandharipande, 2010).

For more than 100 million people in drought-prone areas of Asia and Africa consider lakhodi as a traditional popular crop, because of its easy cultivation, its relative resistance to drought, flood, moderate salinity and insect attack and its good yield of tasty protein-rich seeds (Rutter and Percy, 1984; Abdelmoneim et al., 1997). When other crops fail due to adverse conditions, lakhodi can be the only available food source for the poorest section of the population, and sometimes a survival food in times of drought-induced famine (El-Moneim, 1999).

Since lakhodi is the cheapest food legume that most low-income families can afford, it is a common component of their traditional diet. Its seed also contain a high amount of free *l*-homoarginin, which acts as precursor of lycin in human nutrition (Quereshi et al., 1977). These seeds contain a neurotoxic non-protein amino acid that can cause irreversible spastic paraparesis (paralysis) of the legs when it is consumed as a major portion of the diet over a 3 to 4 month period (Spencer and Schaumberg, 1983; Spencer et al., 1986). Recent outbreaks of famine in areas where lakhodi could be a promising food crop for sustainable agriculture have been followed by upper motor-neuron disease in epidemic proportions (Liu and He, 1990; Haimanat et al., 1990; Haque et al., 1991; El-moneim, 1999).

Most of the anti-nutritional or toxic effects of legumes can be partially or wholly eliminated by proper methods of cooking. This accounts for the fact that heating serves to enhance the nutritive value of many legumes. Since the protein of most leguminous seeds is deficient in methionine, supplementation with this amino acid frequently effects a marked improvement in the biological

value of the protein. However, the effectiveness of methionine and other dietary supplements to counteract the nutritional stress imposed by the toxic components is not yet clear (Liener, 1995).

Conclusion

Based on the literature, it is clear that the Indian feed industry may reach $30 billion from $15 billion of current value in next 5 years. In order to balance the demand and supply, productivity must be increased with proper protein source is an indispensible fact. Present review proposes to incorporate pulses of *Lathyrus sativus* L. (Lakhodi dal) in livestock feed as a protein source to achieve and balance the predicted demand and productivity. A detailed study with pilot scale production of livestock feed with incorporation of appropriate amount of pulses of *Lathyrus sativus* L. (Lakhodi dal) is required to be carried out. So, this review opens up new research avenue to study possibility of incorporation of pulses of *Lathyrus sativus* L. (Lakhodi dal) as an alternative to protein source in livestock feed for socioeconomic development.

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