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Review

Agro-Industrial By-Products as a Potential Source of Livestock Feed

ABRAR A. SINDHU, M.A. KHAN, MAHR-UN-NISA AND M. SARWAR
Department of Animal Nutrition, University of Agriculture, Faisalabad–38040, Pakistan

ABSTRACT

Agro-Industrial By-Products (AIBP) are the important source of protein supply for livestock. In Pakistan, livestock productivity is very low as compared to developed countries, mainly due to underfeeding. The use of AIBP as a part of feed for livestock reduces the cost of production, improve the quality of feed, ensure regular feed supply even during slump period (December-January and May-June) and ultimately increase the profit margin of livestock farmers. In AIBP, many toxic compounds, which are deleterious to animal health and performance, are found but ruminants have the ability to tolerate much higher concentrations of such factors as compared to non-ruminants. Various technologies and methods are also being used to detoxify or at least minimize the effect of these toxins or anti-nutritional factors in animals feed and improve their nutritive value.

Key Words: Agro-Industrial by-products; Livestock; Feed

INTRODUCTION

While raising animals, more than 70% expenditures are incurred on feed. In Pakistan about 16% of the total cropped area is put under fodder crops annually, even than regular supply of adequate and quality fodder is not being made (Hanjra *et al*., 1995). Due to increasing human population, the area under fodder production is decreasing @ 2% after each decade. Thus, underfeeding of our animals is one of the main reasons of low production. This is simply because an underfed animal uses a higher portion of its feed for body maintenance. Thus, less of its feed intake is converted into production/products useful to mankind. This unfortunate situation arises from an inadequate supply of low quality feed during at least part of the year (Sial *et al*., 1988). There may be many options to overcome the shortage of feed for livestock but one of them is the use of Agro-Industrial By-Products (AIBP).

AIBP refer to the by-products derived in the industry due to processing of main products. They are less fibrous, more concentrated, highly nutritious and less costly as compared to crop residues (Aguilera, 1989). Thus, feeding AIBP will help to decrease feeding cost especially in developing countries like Pakistan.

Agricultural crop residues and concentrate by-products. Most common pulses are Urad (*Phascolus radiatus*), Moong (*P. mungo*), Moth (*P. aconitifolius*), cowpea (*Vigna catiang*), Masoor (*Lensasculenta*) and Arhar (*Cajanus indicus*). The husk of pods with leaves and tender stems are left behind as by products which can be utilized as fairly nutritious cattle feed. They are fairly good source of digestible protein (Ranjhan, 1993) and may be used for livestock feeding along with the concentrate mixture (Bhatti & Khan, 1996). Gram husk, arhar, urad, moong and masoor chunies are most commonly available by-products used for feeding the animals (Verma, 1997). Williams *et al*. (1984) and Wanapat *et al*. (1985) reported that urea treatment of straws significantly increase the nutritive value and digestibility. Similarly, Mahmood (1988) found that dry matter digestibility was maximum with 4% urea.

The DCP value of groundnut straw is superior to that of non-leguminous hays and is comparable to that of leguminous hay of cowpea. It can be safely fed along with wheat bran to meet the entire nutritional requirement of the lactating cow producing upto 5 L of milk/day (Ranjhan, 1993). The main limiting factor is however, the level of phosphorus and high crude fiber (38%), which may in warm periods of the year, inhibit feed intake. This adverse effect may be overcome by sprinkling a mixture of molasses and diammonium phosphate or preferably a balanced liquid supplement on chopped groundnut straw (Maglad *et al*., 1986). The nutritive value of groundnut meal can be improved by autoclaving treatment just like guar meal (Sattar, 1979; Akhtar, 1983). Rape bhusa and groundnut husk are very poor in nutritive value like cereal straw. Faulkner *et al*. (1985) conducted a trial on beef cows and found that feeding of NH_3 treated bhusa increased feed intake (13.8%), weight gain (0.3 kg/day) and apparent digestibility of fiber. Maize husk is superior to gram husk in its nutritive value and 50% of the dry roughage portion in the rations of adult non-producing cattle can be replaced by these by-products (Ranjhan, 1993). Wheat bran is very much-used product in formulating feed for dairy animals. It contains about 10% DCP, 65% TDN, 0.07% calcium and 0.35% phosphorus. It can even be fed to sick animals without any ill effects. It produces laxative effect in the

intestine (Verma, 1997). It can be incorporated up to 50% of the total grain mixture for young calves. Bran has amino acid balance superior to that of whole wheat and high in P but low in Ca. They are good source of water soluble vitamins, except niacin (Cheeke, 1991). Wheat middings are similar to bran except that they have lower fiber and higher flour contents, so they are higher in digestible energy than bran. Wheat midding contains 10-14% crude protein and 9.5% crude fiber (Cheeke, 1991). Rice husks contains 8 to 11% water, 15.6 to 22.6% ash, 14.5 to 17.5% acid insoluble ash, 2.9 to 3.6% crude protein (CP), 0.8 to 1.2% ether extract (EE), 39 to 42% crude fiber (CF) and 25 to 29% nitrogen free extract (NFE). Rice husk as such is not palatable (Ranjhan, 1993) and should be used as a part of ration (Deschard *et al*., 1988). Feeding of rice bran alone may result in colic pain due to formation of ball inside the intestine. Hence, it should always be mixed with other concentrates. It contains 7% DCP, 65% TDN, 0.06% Ca and 1.12% P. It is rich in vitamin B-complex. It may be used for feeding cattle, buffaloes, sheep and goat (Verma, 1997). Rice bran is a major feeding stuff in tropical countries, it has high oil content (13%) (Cheeke, 1991). Rice polish contains about 3% fiber, 12% fat and 12 to 14% CP. It is excellent source of energy and rich in vitamin B-complex. It is good feed for Livestock. However, maize gluten feed is rich source of protein (45 to 48%) and very useful for livestock feeding (Verma, 1997).

Sugar industry by-products. Molasses is the readily available source of sugar and phosphorus to the animal body. The urea molasses diet can be successfully fed as a sole ration with little protein supplement and forage to growing calves and lactating animals (Ranjhan, 1993). In concentrate mixture, inclusion of 10 to 15% molasses increases the palatability of the concentrate mixture (Verma, 1997). It contains 20.6% water, 60.8% total sugar, 3.2% crude CP, 2.2% soluble gums, 8.2% ash and 5.0% free acids. The effect of liquid urea molasses diet on the reproductive performance was studied by Pathak (1973) and found no ill effect on semen quality of the bulls. Molasses has also been used as binding agent with urea. Molasses provides the major source of fermentable carbohydrate (Cheeke, 1991). Sugarcane tops are palatable and cattle can be maintained entirely on them with a little supplement of concentrate mixture or leguminous feeds (Verma, 1997). Cane tops can be converted into a good quality silage or hay for feeding during scarcity of fodder. Sugarcane tops with or without leaves have good feeding value and are readily accepted by ruminants either fresh, dried or ensiled (Tariq, 1988; Bhatti & Khan, 1996). Bagasse is a good source of cellulose but is poor in protein (1.3%) and high in lignin (16%). It has been used successfully as roughage for ruminants. High pressure treatment improves the palatability and digestibility of bagasse (Morrison & Brice, 1984). However, digestibility of unprocessed bagasse is low because it contain high lignin content (Bhatti & Khan, 1996). It can be fed upto 4 kg to adult cattle for maintenance after chaffing it. It may be preferably fed by mixing with molasses and wheat bran for good performance of animals. Press Mud can be used in the formulation of livestock feed because it has a higher CP content than molasses and contains more soluble calcium, which is an important constituent of animal feed (Benerjee, 1993). Condensed Molasses soluble/Dried Yeast Sludge is a by-product of various fermentation processes in which large quantity of molasses is used to produce alcohol, yeast, citric acid, monosodium glutamate, etc. This product is a rich source of microbial protein and is useful ingredient of animal feed. After condensation to 65 to 75% dry matter, it is called the condensed molasses solubles (Cheeke, 1991).

Animal by-products. Fishmeal is highly nutritious feed supplement obtained from fish body. It contains about 10% moisture, 55% protein, 6.9% fat and 25% mineral salts particularly 5.4% Ca and 3.4% P. It also contains vitamin A, D and few members of vitamin B-group. Fishmeal is the richest source of vitamins B12 (Verma, 1997). Sterilized fishmeal should be used for feeding the growing and producing animals. The higher percentage of fishmeal in cattle feed is not desirable. Cattle, buffalo, sheep and goat do not like the tankage, until it is mixed thoroughly with some other well liked feed in lesser proportion (Morrison & Brice, 1984; Benerjee, 1993). Bone meal is a nutritious substance obtained from sterilized bones. It contains about 7% CP, 30% Ca, 15% P and 3% fat. In growing and producing animals, it is used for supplementing their needs of calcium and phosphorus (Verma, 1997). However, blood meal is a major slaughter house by-product which contains over 80% CP but is poor in Ca and P, which make it unpalatable to animals (Ranjhan, 1993; Verman, 1997). Meat meal is a rich source of animal protein and may be fed in small amounts to the growing and producing animals by mixing with concentrate (Restic & Kormanjos, 1992).

Poultry slaughter wastes contain 3.42 to 21.35% CP, 0.14 to 17.42% crude fat, 0.54 to 11.31% nitrogen free extract (NFE) and 0.16 to 5.0% ash. Amino acid structure of the proteins indicated that the wastes are valuable raw material for the production of protein feed for cattle (Ristic & Kormanjos, 1992). Poultry excreta is rich source of protein, calcium, phosphorus and minerals and can be used as source of nitrogen in the cattle ration (Ranjhan, 1993).

Industrial by-products. Guar Gum industry by-products contain 42.52% DCP and 83.49% TDN. Verma (1997) reported that this product is being used as a cattle feed. Starch industry by-products contain enough of nutrients, especially protein and are quite useful for feeding the animals (Ranjhan, 1993). Lemon grass oil industry by-products contains 0.64% DCP and 49.76% TDN; hence has got a better nutritive value then straw (Cheeke, 1991) and can be fed to livestock. Antibiotic Industries by-products are obtained from the factories dealing in the manufacturing of antibiotic. Such by-products are quite useful for feeding the animals which results in their better growth and development (Verma, 1997). Dairy Industries by-products

such as skim milk, buttermilk and whey etc are valuable substance obtained as by-products during the manufacture of cream, butter and cheese. These substances are quite rich in nutrients, especially proteins. Hence they are quite useful for feeding the newly born calves (Verma, 1997). Condensed whey is prepared by removing part of the water and usually has a dry matter content of 40 to 60%. Dried whey is a dry white powder, containing 70 to 75% lactose and 12 to 13% CP. It is digested very efficiently by young animals but may cause digestive disturbances due to lactose intolerance in older animals (Cheeke, 1991). Similarly, other Grains milling by-products from barley, sorghum, rye and oats are valuable and may be used as feed for animals (Cheeke, 1991).

Fruit and vegetable by-products. Tomato Pomace contains 14.3% DCP and 65% TDN. After drying and grinding it can be used as a part of animal feed up to 35% level (Verma, 1997). It can replace satisfactory wheat bran on equi-weight bases upto one third portion of a concentrate mixture (Ranjhan, 1993). Citrus pulp contains high amount of soluble sugars with digestibility of 85% and contains about 6.0% CP. It can replace one third of a concentrate mixture without ill effects on the health and utilization of nutrients in buffaloes (Ranjhan, 1993; Verma, 1997). Pineapple bran together with maize grain, wheat bran and molasses, has successfully been fed to draught animals as a source of energy. When supplemented with high protein ingredients; it is like by dairy animals (Verma, 1997). Ranjhan (1993) conducted a study in Philippines on 5,000 feed lot beef cattle, raised on the fresh as well as ensiled pine apple wastes containing peel, pomace and leaves. About 90% of waste material and 10% concentrate mixture when fed to growing finishing steers, a growth rate of 600-700 gm/day was achieved. Dried cashew fruit contains about 9.5% crude protein and 68.5% soluble sugars. Thus, it can replace some of the grains in livestock ration (Aguilera, 1989). Mango seed kernels are the by-products and are available after the mangoes have been consumed by the human beings. It contains 6% DCP and 70% TDN. It is rich in tannins which may vary from 5 to 7%. It can be used as one of the ingredients in Livestock rations (Cheeke, 1991).

Marine wastes and aquatic plants by-products. Various marine (sea) product wastes are available for animal feeding such as fish wastes, frog meal, weeds and aquatic plants etc. Agar-agar is being extracted from sargussan seaweed and its by-products can be used for livestock feeding. This product contains about 33% ash and 10% protein (Verma, 1997). Some of the green and red sea weeds, such as ulva fasciata, U.rigida, porphyra viotnamensis, centroceras clevulatum, etc., contain between 16 to 30% protein. Sargassum sea weeds by-products has been used as an ingredient of cattle feed. This can be used as a source of minerals to the livestock. Fresh water hyacinth *(Eicbornia crassipes)* contains 7.66% DCP 43.73% TDN, and 2.5% oxalic acid (Verma, 1997). According to Bhatti and Khan (1996), milk yield of buffaloes increased by 10-15% when water hyacinth was incorporated in ration. *Lotus (Nelumbium speciosum)* is an ornamental plant and is a rich source of protein for livestock. Cattle and buffaloes relish young leaves (Ranjhan, 1993). *Jhanji (Scirpus articulatus)* is perennial semi-aquatic plant in Pakistan, Bangladesh and India, etc. Dairy animals may consume 1.46 kg/100 kg body weight on dry matter basis without any ill effects on health. It contains 9.3% DCP and 43.9% TDN (Verma, 1997).

Forests by-products. The by-products available from the forest for cattle feeding are dry leaves and seeds. The dry matter contents of most of the tree leaves ranges between 30 to 45% and CP content are also quite high. Ardu leaves *(Alianthus excelsa roxes)* contains 13% DCP and 63% TDN. Adult animals can be maintained on Ardu leaves. Bamboo leaves *(Dendrocalamins strictus)* contains 9.4% DCP and 49% TDN. The leaves in tender stages are relished by the animals as a part of feed. Bamboo leaves contains oestrogenic factor (Aguilera, 1989). Beri leaves *(Zizyphus jujuba)* are mainly used as conventional fodder for sheep and goats. It contains about 18.6% crude protein but the digestibility is very poor (36%) because of the presence of tannins (Skerman, 1977). Mulberry leaves *(Morus indica)* contain about 11.4% protein. These are highly palatable and contain 7.8% DCP and 48.4% TDN (Ranjhan, 1993). He further reported that Neem leaves (*Azadirachta indica*) are not preferred by the animals. Buffaloes can consume only 6 kg per day. The goats consume in appreciable quantity. It contains 6.2% DCP and 52.5% TDN. Nutritive value of pipal leaves (*Ficus religiosa*) is low and not liked by cattle but goat relish this fodder only for maintenance. The leaves contain 5.5% DCP and 39.2% TDN. Tapioca leaves *(Manihot utilissmia)* are rich source of protein, containing 8.3% DCP and 45.5% TDN. Tapioca leaf meal gives good results when fed to lactating animals. Thus, tree leaves can be used as a part of livestock feed (Reddy, 1989).

Miscellaneous by-products. Maize gluten meal generally contains 45 to 48% protein and is fed to cattle as a protein supplement (Ranjhan, 1993). Its use for feeding dairy animals is optimum in Pakistan. Tapioca wastes contain 2.0% DCP and 64% TDN on dry matter basis. It has been successfully used in growing and lactating animals (Ranjhan, 1993). Ranewar (*Cassia tora*) plants grow abundantly during the monsoon in uncultivated and barren lands. The seeds collected from the pods are not palatable to livestock if fed alone but if mixed with other conventional energy or protein rich concentrates they become acceptable to the ruminants (Morrison & Brice, 1984). They also reported that tea industry wastes can be used as a feed ingredient for animals. It contains about 18% crude protein. The oil by-products like palm press fiber, palm oil sludge, palm kernel cake can be utilized as feed ingredients at variable levels. The palm oil sludge can be used upto 10% in cattle rations. Palm kernel cake like rice bran is valuable in supplying protein and energy (Benerjee, 1993).

How to improve their nutritive values? Agro-industrial

by-products are important source of protein supply but their availability is limited for ruminants as compared to poultry. A wide variety of anti-nutritional factors, including various toxic compounds, which are deleterious to animal health and performance are found in these feeds (Table I). The ruminants, in general, have the ability to tolerate much higher concentrations of such factors as compared to non-ruminants. A number of technologies and methods have been developed to detoxify or at-least minimize the effect of these toxins or anti-nutritional factors in animal feeds (Table II) and improved their nutritive value.

Table I. Some anti-nutritional factors in agro-industrial by product feeds

By products feed	Anti-nutritional factor
Rape seed and mustard	Thioglucoside, Goitrin, isothiocyanate
Castor seed meal	Ricin, Hemagglutinin
Cotton seed cake	Gossypol
Linseed meal	Cyanogens, Anti-B6
Peanut meal	Aflatoxin, goitrogen, Protease inhibitors, saponins
Guar meal	Protease inhibitors
Beet pulp	Saponins
Sesame meal	Mineral binders
Soybean meal	Hemagglutinins, Goitrin, Protease inhibitors, Saponins

(Bhatti & Khan, 1996)

Table II. Natural inhibitors in feed stuffs

Feedstuff	Inhibitor(s) toxins	Deactivation process
Cottonseed meal	Gossypol eyclopropene fatty acids	Adding iron salts; rupturing pigment gland
Soybean meal	Trypsin inhibitors an unidentified factor	Heat; autoclaving
Linseed meal	Crystalline water soluble substance	Water treatment
Raw fish	Thiaminase	Heat
Lucerne meal	Saponins: pectin methyl esterase	Limit amount feed
Rapeseed	Isothiocyanate Thyroactive materials	-
Groundnut meal	Aflatoxin	Treatment with ammonia or ammonium hydroxide

(Benerjee, 1993)

CONCLUSION

The use of Agro-Industrial By-Product can be used as a part of livestock feed. Their use will facilitate the farmers for economical and profitable farming, because feeding cost will reduce which is more than 70 percent of the total cost of production.

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