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Popular Article

Food industry byproducts - As potential animal feeds

A.K. Verma*, Sowjanya Lakshmi, R.K**
Head, Division of Animal Nutrition, ** SAARC PhD Scholar.
ICAR-Indian Veterinary Research Institute, Izatnagar-243122, U.P., India
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Agriculture and food industry waste constitutes a major proportion (32%) of world-wide agricultural production. Recovering of nutrients from currently wasted resources and their utilization as feed resource with application of proper processing technologies will help curb the danger of gap between increasing livestock population and available feed resources to meet increasing population demands. Demand for processed foods increased tremendously due to altered lifestyle choice of global consumers with subsequent release of waste production from these processing plants. This waste management in efficient way is essential for enlarging the livestock feed resource base and to reduce food-feed competition. Sugar, starch, beverage industry waste products (beet pulp, molasses, bagasse, DDGS, WDGS, condensed steep liquor etc.) are being used as livestock, poultry and fish feeds. Animal nutritionists made attempts for successful utilization of dried or ensiled vegetable processing and fruit juice industry waste as animal feeds. Although there is successful production of biofuels, bioelectricity from food industry waste, as per United States Environmental Protection Agency (US EPA, 2020) food recovery hierarchy/waste management from food processing industry should be prioritised as follows

1. Feed the hungry people first
2. As animal feed

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3. For industrial use as biofuel at the plant where it is being produced
4. Composting/bio fertilizer
5. Land filling/incineration.

Hence processing of food industry waste for feeding livestock, poultry, fish and its nutrient evaluation being taken as primary area of research by many governmental, industrial and non-governmental organizations globally to meet the demand for animal protein by increasing global population. Recycling of food industry waste as animal essential to fill the large gap of feed requirement and availability and to reduce the impact of waste disposal on environment, while creating employment opportunities, newer entrepreneurial skill development of educated youth.

According to ministry of food processing industries (MOFPI), Govt. of India food processing industries are mainly two types.

a) **Primary processing:** Rice, wheat, sugar, edible oils flour millings. The waste in other terms by-products from these industries are being used as animal feed ingredients.

b) **Secondary processing:** Fruit and vegetable processing, dairy, bakery, beverage, chocolate and other items. Many of these industrial by-products with good nutrients are being wasted due to lack of proper processing and recycling techniques. Interventions by animal nutritionist in collaboration with food engineers are essential in these aspects for using them as effective animal feeds.

For convenience food processing industry in India with potential production of by-products suitable for feeding animals can be categorised as follows.

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Waste/ by-product from food industry for using as animal feed should possess good nutritive value (protein, soluble carbohydrate, fiber and energy rich), economical, should be free from toxins (microbial/chemical) and accepted by the animal. Eco feed is the term used collectively for agro industrial by- products, food and food processing waste being converted to animal feeds with application of proper processing techniques. Techniques used for preparation of these eco feeds includes solid substrate fermentation/ensiling, cooking, wet based methods and dry based methods.

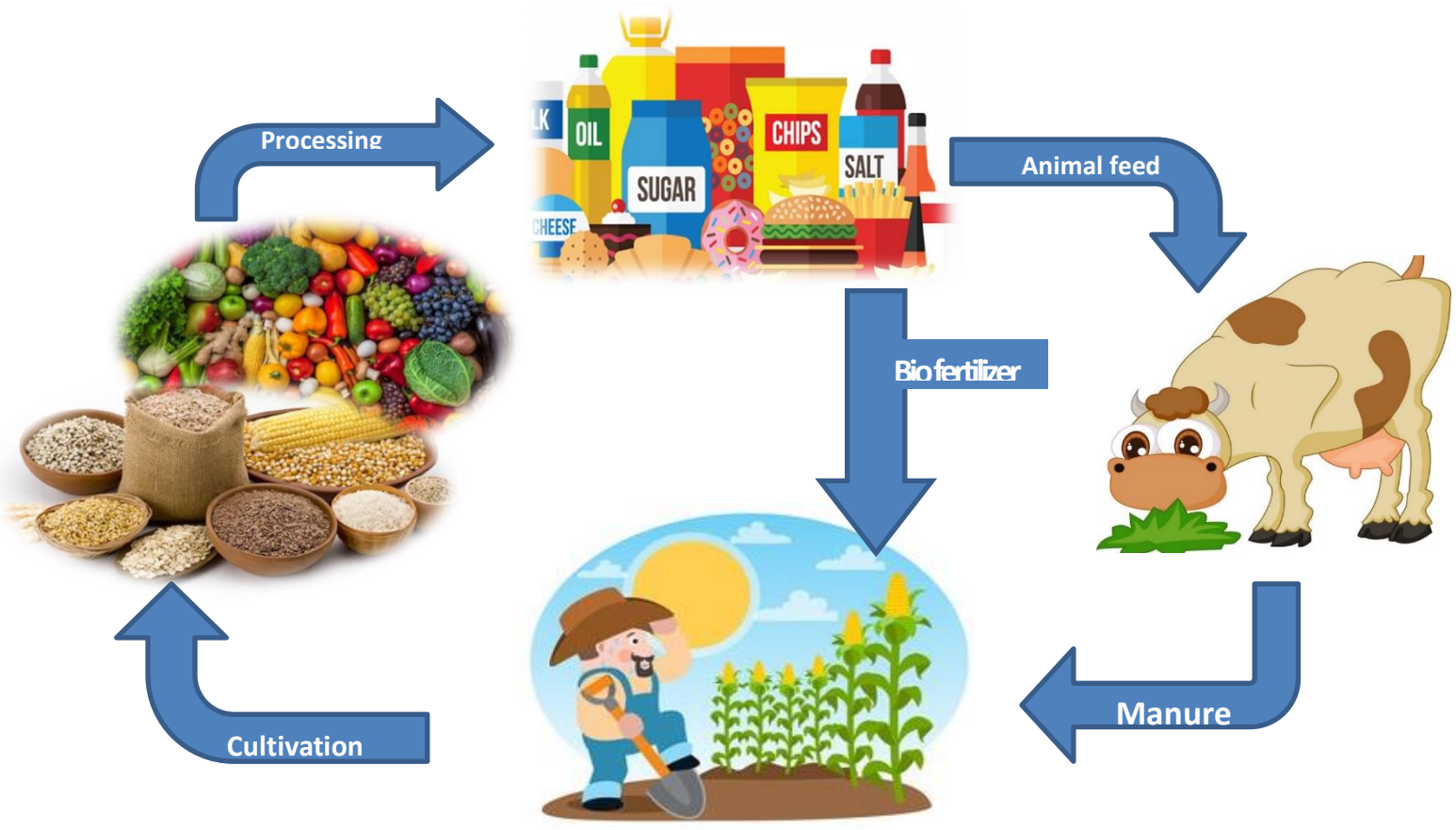

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Table1: Various food processing industries and their waste/by products as animal feeds

S. No	Industry	Waste/by-product	Suitable species for feeding	Nutrient content
1.	Cereal/pulse milling	Brans, broken grains, middling, grain polishing, husks, chunies, endosperms,	Ruminants, poultry, fish, dog and cats.	Low moisture (< 13%), protein and energy rich feeds.
2.	Fruit and vegetable processing	Fruits, Pomace, peels, pulps, skin, seeds, kernel, rind.	Ruminats, pigs and dogs.	High moisture (70-85%) with low protein value. contains starch and soluble sugars.
3.	Beverages like coffee tea and cocoa	Coffee pulp, coffee husk, tea seeds, tea dust, Cocoa shells,	Ruminats, pig, chicken and fish ** not to be included in pet foods	Protein (10-17% and fiber rich (30-40%), less in moisture content.
4.	Meat, Fish egg and poultry products	Meat meal, bone meal, leather meal, blood meal, tallow, lard, feather meal, egg powder by product, fish oils.	Main protein source in pet food industry. Animal protein source in poultry and pig feeds.	Cheapest protein/essential amino acid source per unit. Also rich in essential fatty acid and minerals.
5.	Bread, biscuit and bakery products	Bread and cake crumps, bread meal, biscuit meal, stale bread, floor spills,	Ruminats, pigs, poultry and fish	Low in moisture (20-25%) but high in soluble sugrs, starch and oils.
6.	Malt, Beer/alcoholic beverages	DDGS, WDGS, condensed steep liquor, spent grains, grain husks, grain germs/rootlets	Ruminats, pigs, poultry, pets and fish	Varied nutrient content depending on processing methods. Rich in moisture and fibre. low in fat and soluble carbohydrates.
7.	Edible oil/ fat processing	Oil cakes, oil sludge in refinement process, press muds, empty fruit bunches, oil seed husk	All species.	High protein and energy value. oil cakes are main protein source in animal feeding.
8.	Breakfast cereal, malt processing and extruded foods	Husks, brans, peels, broken meals, endosperms, substandard grains, broken pasta, noodle soup waste	Pigs, poultry, fish	Rich in B- complex vitamin and starch.

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A) **Ensiling/Fermentation:** Fruit and vegetable processing waste are generally rich in soluble sugars, fiber and moisture (>70%). They can be fermented by adding lactic acid bacterial culture to produce ensiled feeds. Vegetable scraps, fruit juice pulps, fruit peels beer residues can be ensiled in the same way as grass silage. Addition of microbial cultures after heating/sterilizing the waste helps to stabilize the product and prolongs its shelf life. Increase in shelf life is by preservative action of released lactic and acetic acid during microbial fermentation process. Advantages of this ensiled feed is improved nutritive value due to increased protein content, available amino acids, essential fatty acids and vitamins. Ensiling of this waste also helps to minimise anti nutritional factors. Pleasant aroma of the ensiled feed improves the acceptability by the animal. Main constraint in this processing method is storage and transportation cost.

B) **Wet based methods:** these methods involve simple heating with steam (70-80°C) for a minimum of 30 min) resulting in high moisture feed. Wet based method has advantage of minimal preparation and is mostly suitable for food waste processing at cafeterias, restaurants. However, shelf life of these products is very low (1-2 day) limiting its use along with high cost of transportation. Alternatively, this processed waste can also be ground, steam cooked, pelleted and dried (110-120°C for 4 to 6 min) and can be marketed as animal feeds.

C) **Dry based methods:** low pressure frying method, boiling- drying method, high temperature fermentation drying method, high temperature method is used to reduce the moisture content to a minimum possible level and also to remove the microbial load. Products processed in this method have longer shelf-life smaller bulk volume compared to wet based methods and easier to use in feed formulations. excess water from the waste can be removed by squeezing machines, pumping of hot air (350-400°C), dryers (microwaves, PCD, static and rotary ovens), or by simple sun drying to reduce the moisture content as low as 10%. The final product can be ground and marketed as feed powders.

(In Japan instead of these ensiling, solid fermentation, cooking and drying techniques food waste is being mixed with water or milk and being supplied to farms in pipelines after fermenting the liquid sludge with lactic acid bacteria to reach a pH of 4. Whereas Indian farmer use the same technique of waste scrap household water feeding to animals from ages).

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However, these processing techniques should consider peculiarities of individual waste, environment in which they are generated/reprocessed, possible toxin contamination for delivering safe and nutrient rich animal feeds. The aim of recycling food industry waste as animal feed mainly needs to target nutritional evaluation with respect to animal species and low-cost technological approach. Research on these aspects should include

- Nutritional evaluation on digestibility and utilization of the nutrients by target species
- Feeding value
- Biohazards
- Feasibility of long-term storage
- Stability of nutrients under different processing techniques.

Level of inclusion in animal feeds: Substitutional range of these waste/by- product inclusion in livestock, fish and poultry feeds ranges from 10-100% depending on their nutrient characteristics/ composition.

Constrains in usage of these waste/by-products as animal feeds

a) High moisture content which needs proper drying for long term storage and ease of transportation
b) Availability on regular basis which is based on seasonal raw material availability, market demand and ingredient cost.
c) Inconsistency in terms of nutritional value
d) Lack of managerial skills and capital resource for purchase and operation of suitable technique.
e) High recycling cost compared to traditional feed ingredients
f) Low quantity of waste production as most of the processing industries are small and medium scales with scattered locations.
g) Presence of anti-nutritional factors and possibility of chemical contaminants used in food processing.
h) Lack of marketability of end product for animal feeding.

Apart from animal feeding as part of zero waste programme/zero land filling programme, waste products not suitable for animal feeding can be used as source of bio fuels like bio CNG, bio methane by anaerobic fermentation and electricity can be produced from these gases which can be

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used at the processing plant. Fat/oil can also be extracted from this waste and can be used as fuel/energy source. Composting of this waste by vermicomposting produces valuable bio fertilizer for enriching the soil fertility in eco-friendly way.

Conclusion:

Food processing industry waste/by-products are nutritious and are suitable for animal feeding. Recycling of these products for animal feeding helps meet growing feed demands and protects the environment from potential land pollution. Primary food processing industry by-products are used as animal feeds and secondary food processing waste are being researched for inclusion in animal diets. Future research should address the characterization of nutrient variability of food waste/by-products, development of timely waste collection, economic processing and transportation of these food industry waste for incorporation in livestock, poultry and fish diets. Nutritional research needs to be concentrated on novel product preparations (feed blocks, pellets, fruit bars with technological interventions) with safe level of inclusion for better economic feasibility without compromising animal`s performance.

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