The Bulk Extraction and Quality of Leaf Protein

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1 Introduction

Whether concern is directed towards the needs of a less-developed country with a food shortage, the problems of a country where there is a surplus of grain while fishmeal and oilseed residues are imported as feed for pigs and poultry, or towards the more general matter of making farming more efficient, protein extracted from leaves (LP) deserves attention. There are many reasons for this, for example:

1. Leaves are the primary site of protein synthesis and protein is lost when translocated to seeds or tubers.
2. Suitable crops maintain a photosynthetically active cover throughout the period in which growth is possible. Yields are therefore greater than with any other type of crop. LP is therefore potentially the most abundant source of protein. Conventional leafy vegetables share this merit. Increased use of them would be advantageous, but the amount of fibre which accompanies the protein in them sets a limit to consumption.
3. Ruminants return as human food only 5 to 30% of the protein they eat, whereas 50 to 60% of the protein in a leaf crop can be extracted.
4. Species rejected as human or animal food because of texture or toxicity can be used as LP sources. When the LP is washed, flavour and toxic material are usually removed. Ruminants readily eat the extracted residue and do well on it, because, coming from young plants, it is less lignified than a crop which, untreated, has the same N content. Because it has been pressed, there is no drip when it is ensiled, and less fuel is needed than with a normal crop to dry it completely for use as winter feed.
5. If made carefully, LP is nutritionally better than the usual seed proteins; but not as good as egg or milk. Like other proteins which contain carbohydrates and unsaturated fats, it is damaged by inept handling.
6. Extraction equipment can be simple enough for use in villages; equipment for large-scale extraction has also been designed.
7. People with European or North American prejudices find the appearance of LP unusual at first. They soon accept it, and no problems with acceptance have been met anywhere where it has been intelligently presented.
2 Species

Protein is extracted more readily from soft, lush leaves than from those which are fibrous and dry. Even when pulped with added alkali, extraction from acid leaves is not as successful as from those with a neutral juice. Extraction is usually poor from leaves containing much phenolic material (Butler 1982), and glutinous or slimy leaves are inconvenient to handle. The greater the protein content, the greater the extraction percentage. A striking example (Arkcoll and Festenstein 1971) was the greater LP yield from unmanured kale (Brassica oleracea) than from kale given P and K, but no N. Because the latter grew more but did not synthesize more LP, more of its LP was retained in the fibre. For similar reasons, LP becomes more difficult to extract as leaves mature. Generalizations regarding species are hazardous because varieties of the same species can differ greatly. Fat hen (Chenopodium album) is an extreme example (Arkcoll 1971; Carlsson 1975). Nevertheless, protein can be extracted well from more than 100 species. As would be expected from its use for lawns and playing fields, grass does not extract well unless given special irrigation and fertilization. Most of the LP used in feeding experiments was extracted from lucerne (Medicago sativa), although its juice froths inconveniently and its LP has a stronger flavour than the LP from many other species. At Rothamsted we prefer rape (Brassica napus) or cereals; the latter produce useful second harvests which can be followed by such species as mustard or radish. In tropical and subtropical regions, berseem (Trifolium alexandrinum) and cowpea (Vigna unguiculata) are excellent sources. Crops such as these should be harvested with a reciprocating blade which deposits them onto a belt. They accumulate dirt if dropped on the ground before being collected, and they rapidly deteriorate if harvested with a flail. There is no apparent disadvantage in using mixed species. Leaves as a by-product are an attractive source. Sugarcane tops are probably too fibrous to be a useful source. Results with cassava are conflicting; it is not always clear that the leaves used in successful extractions were taken at the time of normal harvest. In Britain, potato (Solanum tuberosum) and sugar beet (Beta vulgaris) tops extract well. They could yield about 0.1 Mt of protein annually (Pirie 1987a).

Most tree leaves are too dry and hard to extract well, but some, e.g. elder (Sambucus nigra), are satisfactory. Leaves could be harvested from coppiced trees grown as fuel.

Many species, classified as weeds, are satisfactory but they would be eliminated if systematically exploited. If any species were found to have merit, it would have to be cultivated as a new crop. Water weeds are an exception. Many of them, e.g. water hyacinth (Eichhornia crassipes), persist in spite of strenuous attempts to control their growth. LP extracted from it is used as a starter feed for calves; the residue is fed to ruminants (Borhami and El-Shazly 1990). Two million ha is said to be infested with water