THE COMPOSITION AND POSSIBLE USE FOR FEED OF SOME CROP RESIDUES

WILLIS D. GALLUP, Oklahoma Agricultural Experiment Station, Stillwater

Crop residues and wastes comprise those parts of plants (largely stalks and coarse stems) which are left in the field after the crop is harvested or, as in the case of hulls and husks, are removed with the crop and later separated from it in threshing and milling. The composition of these plant materials is characterized by a large proportion of tough, fibrous substance and a small amount of soluble extractives. Their properties are such that no extensive use is made of them in industry, although it is estimated that crop by-products classified as agricultural wastes amount to over 84 million tons annually. Some of these wastes have been used as raw material in the production of cellulose compounds and a few have been utilized in the manufacture of insulation material of acceptable quality.

According to the conventional scheme of analysis used to describe feed stuffs, most of these crop residues show a high percentage of crude fiber, a low percentage of protein and fat, and variable amounts of nitrogen-free extract (starch, sugar, etc.). Their proximate composition thus resembles that of grass hays and cured forages, and from this viewpoint they might be regarded as roughages suitable for livestock feeding. Successful attempts to improve their feeding value by chemical treatment have been made in several foreign laboratories, largely as a result of feed shortages during times of war. The cost of treatment, however, has not made this practice profitable under ordinary conditions.

The composition of a number of crop residues suggested as possible feed for livestock is given in Table I. The composition of some common roughages whose feeding values have been fairly well established is included in this table for purposes of comparison.

RESULTS

It should be noted that the composition of various parts of the cotton plant shown in Table I compares favorably with that of cottonseed hulls. Hulls are extensively used as a feed for cattle, whereas the burs and undeveloped bolls, which accumulate around gins distributed throughout the cotton-producing area, are seldom used for this purpose. The few digestion trials that have been conducted with these gin wastes indicate that they have a higher nutritive value than is usually assigned to them, and that they contain about the same amount of total digestible nutrients as cottonseed hulls. Their economic importance as feed has not been thoroughly investigated.

Peanut forage, like other legumes, contains a high percentage of protein. When cured without too great a loss of leaves and fine stems it makes a valuable hay. Even the large stems, unless severely weathered, are relatively high in protein and nitrogen-free extract. Peanut shells, however, are classified as poor feed because of their high crude fiber content. Commercial shells frequently contain nut meats in amounts sufficient to increase their protein and fat content well above that of common roughages. Their nutritive value is determined largely by the proportion of meats present.

Oat, barley, and wheat straws are very similar in proximate composition, although oat and barley straws are credited with having the greatest feed value. Likewise, corn husks, corn cobs, and oat hulls have similar compositions and any preference for one or the other of them for feed is based largely upon practical feeding experience. Reports by different investigators on the total digestible nutrient content of these materials are in poor agreement.

TABLE I

Average percentage composition of the dry matter in some crop residues and common roughages [a]

	Ash	Protein	Ether extract	Crude fiber	N.F.E.
Cotton Plant					
Green plant, lint and seed immature	6.3	9.8	4.2	33.4	46.2
Mature plant, after cotton picked	5.7	6.5	2.8	37.8	47.3
Stalks, mature	4.6	6.3	0.8	47.3	40.8
Stalks and burs, mature	6.0	6.4	1.2	45.0	41.4
Leaves, mature	17.3	16.8	7.6	10.9	47.0
Bolls, immature and damaged [b]	5.0	13.6	5.6	33.0	42.8
Burs, dried in field [b]	5.4	3.7	2.3	39.5	49.1
Burs, commercial, no seed	8.4	7.3	2.0	40.7	41.6
Burs, commercial, some seed	7.2	10.0	2.8	39.0	41.0
Seed hulls, commercial	2.8	4.1	1.0	52.0	40.1
Peanut Plant					
Whole plant, mature	7.0	13.9	10.5	23.4	45.2
Plant top, mature	8.8	11.2	1.8	23.0	55.2
Stems, mature	7.7	8.6	1.1	26.1	56.5
Hay, commercial	11.2	11.1	3.4	24.9	49.4
Nuts, with shells [c]	2.6	20.9	31.3	23.6	21.6
Shells, cleaned	4.6	6.7	1.4	69.5	17.8
Shells, commercial	5.7	10.0	4.0	57.0	23.3

Miscellaneous					
Oat straw	7.5	4.6	2.6	39.8	45.5
Barley straw	6.6	4.1	1.7	41.9	45.7
Wheat straw	7.5	4.4	2.6	39.5	46.0
Oat hulls	7.0	4.3	1.6	32.7	54.4
Corn husks	3.3	3.6	0.9	33.6	58.6
Corn cobs	2.6	3.2	0.5	36.0	57.7
Commonly Used Roughages					
Prairie hay	9.0	5.3	2.2	32.6	50.9
Alfalfa hay	9.5	18.1	2.2	30.5	39.7
Corn silage	5.6	8.1	3.3	21.9	61.1
Sorghum silage	6.7	5.7	3.4	24.4	59.8

[a] With the exception of mature cotton leaves, commercial peanut shells and "miscellaneous" group, the analyses shown were made in the Agricultural Chemistry Research laboratory.

[b] Collected from field after the cotton was picked.

[c] Includes all immature and mature nuts on the vines just previous to harvest.

DISCUSSION

Factors which are not shown in Table I but which are of no less importance than composition in estimating the feeding value of crop wastes are palatability, energy value, the availability of the nutrients in digestion and metabolism, and the content of vitamins and other less well-defined nutrient essentials.

Palatability is often a determining factor in the utilization of these materials as feed. Coarse and stemmy materials are best utilized if they are chopped and combined with a more palatable feed. Whether or not the additional cost of preparation is offset by an increase in nutritive value can be determined only by actual feeding trials. The digestibility of the nutrients in most roughages is unaffected by chopping and grinding.

The energy value of all crop wastes of high fiber content may be presumed to be low, although only a few energy determinations have actually been made. The metabolizable energy and the content of digestible nutrients in crop residues are probably more useful measures of their value in maintenance rations than is their net energy (productive value). The former values, which for all feeds are in a general way related to their proximate composition, need careful study, especially in their application to practical rations representative of those that would be employed in feeding these products to ruminants.

Two important vitamins associated with good roughages are vitamins A and D. The former, which is directly related to the green color of plant material, is rapidly lost from mature plants left exposed to the sun and weather. Vitamin D, which is an important constituent of sun-cured hay, has only a limited distribution in plants. Very little, if any, of either of these vitamins is present in most crop wastes. Other important vitamins, some known and others postulated, are usually present in greatest abundances in leaves and seeds and may be of little consequence in other plant portions.

Another consideration of importance is the distribution in crop wastes of constituents that make up the various nutrient classes shown in a proximate analysis; for example, the calcium and phosphorus content of the ash, the proportions of cellulose and lignin in the crude fiber, and the amount of true fat in the ether-extract. A knowledge of the distribution of these and other comparable constituents provides a sound basis for the formulation of rations in which a choice of supplements is to be made.

The results of practical feeding trials indicate that crop wastes in general have a low feeding value and that some of these products, despite their similarity in composition, have a much lower value than others. Frequently, however, these relative values have been obtained under experimental conditions which did not permit the feed in question to exert its full effect. Consequently, such values are limited in their application, being restricted to conditions comparable with those under which the experiments were made. For example, in feeding a winter maintenance ration, two roughages differing essentially in crude fiber content may appear to have about equal value, whereas in feeding these two roughages in a ration for productive purposes the one having the lower crude fiber content will likely have the higher value. This is possible because of the less rigorous nutrient requirement of animals for maintenance and the greater value of crude fiber for maintenance than for production. Likewise, in a comparison of the productive value of two roughages of unequal vitamin A (carotene) value, when fed with a supplement of white corn, the roughage of the higher vitamin A value will appear to have a higher feeding value, whereas this difference may entirely disappear, or even be in the opposite direction, if vitamin A is supplied in the ration either by direct addition or by the simple replacement of white corn with yellow corn of high vitamin A value. The need for careful control in all feeding experiments cannot be over-emphasized.

Ruminants, because of the complex stomach, are better adapted than other farm animals for the utilization of crop residues and roughages in general. The rumen, which accounts for over 75 percent of the stomach capacity (40-50 gallons in mature cattle), serves as a fermentation chamber where bulky, fibrous feeds are softened, fermented, and partially digested. In this process the cell walls of plants are broken down and the more valuable nutrients within the plant cells are made available for digestion and absorption as they pass through the rest of the gastrointestinal tract. Animals with simple stomachs are less capable of handling large amounts of bulky feeds and have a limited capacity to digest crude fiber. Further, ruminants are less specific than animals with simple stomachs in their requirements for protein and vitamins. They are able to convert simple forms of nitrogen to protein in significant amounts and to synthesize many of the vitamins associated with the vitamin B complex, both processes taking place in the rumen.

Apart from their ability to subsist on coarse feeds, it is of wide economic importance that ruminants are efficient processors of plant material in the production of food for man. They not only produce from roughages a food concentrated in energy, but in the process of conversion they increase the biological value of many of the constituents originally contained therein. Examples of this are the increased biological value of the proteins and the increased availability of the carbohydrates and of certain minerals and vitamins in animal products. In addition to this, they contribute the unrecognized dietary factors associated with meat and animal products. The extent to which crop residues can replace ordinary feeds in ruminant rations without serious impairment of the above function continues to be an attractive field of investigation.

SUMMARY

Most crop residues and wastes have a low nutrient content as indicated by their proximate composition. When properly supplemented, however, these materials should be of considerable value in maintenance rations for mature animals. Ruminants are best able to utilize crop residues because of their unique capacity to digest large amounts of crude fiber and to synthesize significant amounts of protein and certain vitamins. Conditions which provide for the maximum utilization of these products by farm animals have not been thoroughly investigated. This appears to be a timely subject for further study.