Utilization of Waste Proteins in Animal Feeds

by

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Abstract

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Combinations of molasses, urea (NPN),. Phosphoric acid and two levels of Red Blood Cell (RBC) concentrate were studied to determine their stability, animal acceptability and animal response.

Lab. Test tubes and half gallon batches were made of the two liquid supplement mixtures to study their performance.

The supplements were chemically analyzed for protein and phosphorous. In vitro D. M. digestibility at 24, 48 and 72 hrs was determined by running triplicates and using molasses as a control. The supplements were fed free choice, cafeteria style for 17 days, allowing 1 week for adaptation period.

The two mixtures showed considerable stability of up to eight weeks, when they started to show a loss of moisture; the protein content ranged from 31 to 34%, the phosphorous level on both mixtures was .3%.

The in vitro dry matter digestibility data show that the digestibility level of both mixtures is high. Especially notable was the fact that the 20% RBC mixture was slightly higher than the 10% RBC.

As measured by voluntary intake, the acceptability of the 10% RBC mixture was greater than that of the 20% RBC

mixture. This was significant at the .01 level. Average consumption was 3.34 lbs/head/day for the 10% while only 1.09 lb/head/day for the 20%. When feeding only the 20% RBC mixture the intake level was considerably higher than when both mixtures were offered.

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Introduction

According to a recent United Nations report, the world is currently short 21% of the protein it needs to feed its people.

Shortage of animal proteins sources is a special problem of many developing countries. This is attributed to the low efficiency of production associated with a dependance on forages and pastures, and a lack of high energy concentrates in the feed supply available for beef production.

In most developed countries beef production, a major source of animal protein, has been intensified by the use of high energy diets which are composed mainly of grain. However, the developing countries cannot produce grain in sufficient quantities, or purchase grain economically enough, to justify its use as a feedstuff.

In the developing countries most grain is used for human consumption. However, by-products of the different industries can be utilized for beef production in their areas.

Currently in the tropics a high percentage of beef production is centered around forage programs. In these areas two major problems exist: 1) The greatest of these is the seasonal effect on forage yield. Large differences in forage growth exist between the wet and dry seasons, and the question is whether a liquid supplement can be used to supplement during the gaps, when forage production

is low. 2) Another problem is the relatively moderate rates of gain by young cattle grazing tropical forages. Gains of about .7 kg (1.5 lbs)/animal/day were reported by Pate and Coleman, (1975), as average for growing cattle on tropical pastures when adequate forage is available.

In modern beef production it is desired that cattle make rapid gains because of the effect of animal age and finish on beef quality.

LITERATURE REVIEW

The growth of the liquid feed industry, since World War II, has been phenomenal. Competitive prices, potential savings of labor and self-feeding practices have been a major factor in this growth industry. The industry is established throughout the world and may even become more important in future years (Schake, 1976).

A large number of manufacturing processes (brewing, slaughter plants, canning and others) produce large volumes of by-products that must be diposed. Today, sewer taxes and the alternative of drying are both becoming more expensive. Thus, they should be replaced.

Slaughter animal blood is a potential source of large quantities of animal protein. For example, from January to May in 1971, 8.829 billion pounds of cattle were slaughtered in the United States. Over this five month period a good portion of the 12.5 million pounds of available blood protein probably was wasted as an organic pollutant when it could have been converted to a dietary nutrient. Much of it was treated to reduce the Biological Oxygen demand level prior to disposal of the hulk volume as sewage. This expense must be borne ultimately by the consumer of meat products (Landmann and Dill, 1975).

TABLE I

ESTIMATED YIELD OF DRIED BLOOD
PER 1000 LBS OF LIVE WEIGHT

CATTLE	7.0 LBS
HOGS	5.0 LBS
SHEEP	6.3 LBS

TABLE 2

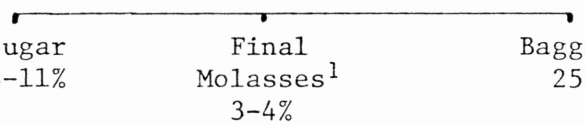
COMPOSITION OF WHOLE BLOOD

Water	77-81%
Protein	18-23%
Carbohydrates	.06-.09%
Lipids	.36-.80%

Probably the main by-product of sugar production is molasses. It has been fed to beef cattle for many years, mainly as an additive to increase palatability and to improve pelleting characteristics in conventional mized rations. Molasses has also been used as a vehicle for other nutrients in liquid feeds, which have been used primarily as a supplement for range cattle.

FIGURE 1

BY-PRODUCTS FOR ANIMAL FEEDING WHICH ARISE DURING NORMAL SUGAR PRODUCTION



[1] contains 20% moisture
[2] contains 50% moisture

The composition of final molasses appears to be reasonably homogeneous from country to country, except with respect to its potassium content, which probably reflects fertilizer practices and soil composition in the anginal cane lands (Preston and Willis, 1974).

TABLE 3

COMPOSITION DATA FOR FINAL MOLASSES

	Mauritius	USA	Cuba
Dry Matter	80.4	74.5	79.6
Sucrose	33.6	52.2	35.0
Reducing Sugars	13.5		17.0
N x 6.25	5.06	4.30	3.40
Minerals	9-10	8.10	5.54
Potassium	3.42	2.38	2.00
Calcium	1.11	0.89	0.71
Phosphorous	0.10	.08	.06
Magnesium	0.60	.35	.45

With respect to its suitability as the major component in an intensive ration, attention should be directed to these factors (Preston and Willis,1974):

1. It has no roughage characteristics, in contrast to other high carbohydrate feeds such as cereal grains.
2. It contains very little nitrogenous material in the dry matter, and of this only 1/3 is considered to be in the form of amino acids, and furthermore these appears to be in highly soluble form. At best, then, the existing nitrogenous material in molasses cannot be considered as other than a source of N for microbial growth.
3. It is a good source of all major and minor mineral elements with the exception of Phosporous, in which it is highly deficient in relation to animal requirements, and sodium, the need for which is enhanced due to the presence of so much potassium In certain circumstances there may also be a need for additional manganese, copper, cobalt, zinc and selenium, one or all which have been detected in low concentrations in molasses arising from specific regions.
4. The form of the readily available carbohydrate in molasses is entirely as highly soluble sugars-mainly sucrase and the reducing sugars glucose and fructose-which has important consequences in relation to the pattern of rumen fermentation associated with high levels of molasses feeding.

Components of liquid feed supplements

Most liquid feed supplements utilize molasses as the primary nutrient-containing liquid. Molasses will provide energy for growth, maintainance and, if intensively fed, for gain. At the same time it will increase or add palatability to the liquid feed as well as serve as the carrier for added nitrogen, phosphorous and vitamins.

Urea is the major source of NPN utilized in liquid protein supplements. Alternatives include biuret, ammonium salts, and diammonium phosphates (Schake 1976).

Vitamins have been added to some liquid supplements, especially vitamins A, D, & E, and all of them with no stability problem in the liquid feed.

Mineral supplementation in liquids has not been a major limitation, except in the case of calcium since most calcium salts are quite insoluble (Schake, 1976).

Phosphoric acid and other phosphorous sources have an important sole in liquid supplements since they have high biological activity and reduce the pH of the supplement, which inhibits ammonia formation from NPN sources. Remember molasses and forages are low in phosphorous.

Drug additives can also be incorporated, depending on the use of the liquid supplement. Antibiotics, like Oxytetrocyclene, chlortetracyclene, sulfamethazine, neomycin and others. Growth promotants have also been added. DES was shown to stratify itself when stored without agitation for extended intervals. MEA has excellent mixing and stability qualities and has found wide spread acceptance (Schake, 1976).

Recent work by Dow Chemical Company indicated that nearly any

solid material could be suspended in a molasses-water solution for a considerable period of time if bentonite clays were included. This should offer some flexibility in the formulation of liquid feed of the future.

Nitrogen Utilization (Estrada, 1973)

Rumen microorganisms hydrolize part of the soluble feed proteins to peptides and then to amminoacids. Some of these a.a. undergo deamination into organic acids, ammonia and carbon dioxide. The ammonia N is absorbed as ammonia then the rummen walls where it is carried to the lines via the portal blood circulation and converted to urea. This urea returns to the blood and passes to the saliva by means of passive transport and then to the rumen. A portion of the urea in the blood passes directly from the blood into the rumen across the rumen wall while another portion is lost by the animal when it is excreted in the urine. This physiological pathway of nitrogen utilization has been extensively studied and generally accepted. According to numerous researchers the deamination process in the rumen represents a serious loss in availability of dietary protein to the animal. The workers emphasize that the total amount of nitrogen lost due to the transformation process is dependent on how fast the bacteria in the rumen utilizes Nitrogen for the formation of their protein. The amount of N lost due to the transformation process is dependent on how fast the bacteria in the rumen utilizes the nitrogen for formation of their protein. On the other hand, NPN ingested by the ruminant also rapidly degraded into ammonia nitrogen in the rumen from where it follows the same pathway as the ammonia nitrogen produced from true proteins.

Studies by Hungate & Southerland cited by Preston (1969), showed that the energetic limitations imposed by anaerobic condition in the rumen allow for synthesis of less than 50% of the protein requirement of a young fast growing animal. Other workers have indicated that the performance of an animal is limited when more than 50% or 60% of the dietary nitrogen comes from NPN sources (Preston 1970).

Boleman, Lichtenwalnen and Riggs et. al (1975), demonstrated that the performance of growing beef calves when fed urea in a liquid feed supplement was lower than when a natural protein-source was included in the supplement.

Wood et. al (1969) reported that feeding soybean meal only during the first 21 days of a feeding period, fallomed by feeding a molasses-urea supplement, supported greater animal performance than if molasses-urea were fed the entire time.

Protein Solubility (Estrada, 1973)

The amount of protein degraded in the rumen by the microorganisms depends on its solubility in the rumen liquor; the amount that escapes bacterial action in the rumen is hydrolized to animo acid later in the abomasum and small intestine.

If a highly soluble portein is used to supply the deficiency of microbial protein production of an animal in high production which is being fed NPN, the objective is not truly achieved because the soluble protein is degraded in the same fashion as NPN. A non-degradable rumen insoluble protein will give a better result. In this respect, Preston et. al. (1965) found fish meal to be a good quality protein with low rumen solubility.

Several experiments have shown that when heat is applied to protein in the pressence of carbohydrates its rumen solubility and bacterial degradation are reduced. Hogan & Weston (1967) and Hudson (1969) have found that heat-treating soybean meal reduces its ruminal degradation and improves abomasal protein quality, but a large percent of this protein is not absorbed which indicates lowered postruminal digestability.

It is deduced, then, that the amount of heat applied is of critical importance.

In another experiment, Whitelow & Preston (1963) concluded that rumen solubility is of minor importance in ground nut meals but of major inportance in fish meals when these are included in early weaning diets for calves.

Experimental Procedure

The experiment was conducted at Texas A & M University, College Station, Texas.

I. Blood Collection

1) Blood was collected by the USDA approved prodecure for collecting edible blood.

2) At collection, whole blood was mixed with an equal volume of cold (33-35° F) aqueous solution prepared as follows:

> Water containing .85 NaCl and also containing 500 mg. of Sodium citrate per liter of blood to be added to the solution.

The diluted whole blood was maintained cool until used.

II. Separation

1) The diluted blood was held at 33 to 35° F and was separated by a centrifugal milk separator (by gravitational flow).

2) The red cell concentrate was maintained at 35° F and was ready for processing into the liquid feed supplement.

3) The serum fraction was also held at 35° F and is processed for spray drying.

If the RBC concentrate was to be stored for a few days before processing it was maintained at 35° F to prevent coagulation before mixing.

III. Formulas developed

Percentage Composition by wt. of liquid Supplement Mixtures containing RBC concentrate from animal blood. (30% C P Equivalent)[1]

Table #4

Ingredient	Mixture Containing 20% RBC	Mixture Containing 10% RBC
Molasses	72%	80%
RBC conc.	20%	10%
Urea	7%	9%
Phosphoric acid	1%	1%
Total	100%	100%

IV. Shelf Life and Chemical Analysis for Protein and P.

Shelf life was determined first by making test tube samples. The samples were checked continously for coagulation or gelatinization, which was determined visually by running the samples back and forth, gas production, determined by leaving the test tubes closed and releasing the cap slowly (if gas is produced a pressure will be formed inside), amount of bubbles and foam were also considered.

Overall this was to check stability and spoilage ability of the liquid feed supplement.

After 3 months of observation and checking on the test tube samples, two ½ gallon samples were made to test outdoor performance and weather response. These samples

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[1]The figure may vary since there is variation in C. P. content within a feedstuff. If this was going to be produced commercially feedstuffs should be tested before formulation to assure a level to the buyer. (Molasses alone can vary from 3-8% in C. P. content).

were left outdoors the months of December, January and February.

Chemical analyses for protein and Phosphorous were run on both samples. Kjehldahl was used to determine the C. P. content on both samples, however since the needed equipment to run phosphorous content was not set up in this particular laboratory at this time, the two samples were sent to the Ag. Analytical Service for phosphorous analysis.

V. Dry Matter In Vitro Digestibility of the liquid supplements and molasses alone as a control.

About 2-3 grams of the samples to be tested were deposited in each jar (triplicates were run for more accuracy), then the rest was filled with saline solution and a special mesh was placed over the top by means of a rubber band. The purpose of this fine mesh is to allow the bacteria in and out of the jar but keep the sample in and the outside forage out.

After the tare and gross were determined on all samples, the samples were arranged to be in three different wide mesh bags to be removed at 24, 48 and 72 hrs respectively.

After the different times were over, the samples were cleaned up with water to remove any particles that might have been around the outside and oven-dried for 24 hours. They were then weighed to compute the percent dry matter digestion. It was also necessary to find the Dry Matter , to compute D. M. D.. The dry matter of molasses (control)

20% RBC and 10% RBC duplicates were run for more accuracy.

This was performed in Texas A & M Nutrition Field Laboratory with the help of Dr. R. E. Lichtenwalner.

VI. Animal Acceptability Trial

Five half sib Hereford heifers from the herd of TAMU were used to determine the animal acceptability of the two liquid supplements. They ranged from 475 to 525 lbs in wt. and were penned individually at TAMU Beef Center facilities. Such a uniform group was selected to avoid deviations.

Sorghum hay and mineral salts were fed ad libitum. One bucket for each mixture was placed in each pen, both supplements were fed self-serve cafeteria style.

One week was allowed for adaptation period to the liquid feed supplement, since it contained urea. During the period the animals were fed 1 lb/animal/day up to 4 lbs/animal/day of the 10% RBC mixture, since it was the highest in urea content and because the supply of RBC was short at that time.

After the adaptation period, the two mixtures were offered free choice for nine days at 3 lbs/animal/day of each mixture. We were temporarily out of the 10% RBC mixture and our source of blood had none available for a period of 7 days. During this period the 20% RBC was fed all the time, and during the first 4 days straight molasses was fed to compare against 20% RBC. This was not planned but it had to be done.

The next eight days after the feeding of both mixtures

started again they were fed 4 lbs/animal/day the first day and from then on both were fed in adequate amounts to enable them to eat as much as they wanted until the end of the trial.

The position of the buckets in which the mixtures were fed were switched to prevent "convenience" error.

This intake data was analyzed statistically for significance results.

Results and Discussion

I. Stability and Shelf Life of Liquid Supplements

The overall stability of the mixtures was good, only a very small settlement of RBC occurred during a two month period. It was observed, however, that the mixtures got thicker due to moisture loss during the period, especially the 20% RBC mixture, which had a greater moisture content.

The shelf life of the mixtures was very acceptable since both had no signs of bacterial or mold growth or of odors of decomposition.

The gas production of the test tube samples was relatively low, compared to samples without phosphoric acid and samples with propionic acid instead of phosphoric acid as a preservative.

II. Chemical Analysis for Protein and Phosphorous

Both liquid supplements were formulated to have 30% Crude Protein equivalent. The NRC values for the feedstuffs were used in formulating the mixtures. We must keep in mind that these are average values that have a wide variation in some cases. The average CPE for RBC is 50%, however this varies some depending on separation speed used.

The Kjehldahl results for CPE were:

10% RBC mixture - 31.49% CPE
20% RBC " - 33.95% CPE

The following formula was used:

$$\%CPE = \frac{.02144 \text{ N HCl} \times 1.4007 \times \text{ml HCl}}{\text{sample wt. (gm)} \times 5 \text{ ml (amt of sample)}} \times 6.25$$

20% RBC mixture

	1st Kjehldahl	2nd Kjehldahl
sample wt	.2834 gms	.2834 gms
HCL mls	2.607 mls	2.520 mls
CPB %	34.53%	33.379%

Average 33.95%

10% RBC mixture

	1st Kjehldahl	2nd Kjehldahl
sample wt	.2574 gm	.2574 gm
HCl mls	2.100	2.220
CPB %	30.623%	32.375%

Average 31.49%

The phosphorous content of both mixtures was .3%, determined by the Ag. Analytical Service. This level of phosphorous is adequate for range cattle. Since these are liquid supplements, these levels should be increased to, .7%, which is the average the liquid supplement industry uses. (McCullough, 1976).

III. Dry Matter In Vitro Digestibility Results

To compute these, the dry matter content of both mixtures and molasses as a control was determined.

Sample I D	Final % Dry Matter
Molasses	72.5048
20% RBC	63.0499
10% RBC	67.3038

The results of the D.M.D trial are as stated in Table #5.

Table #5

Sample I D	Final % Dry Matter Digestibility
Molasses:	
24 hrs	78.60
48 hrs	74.24
72 hrs	98.50
20% RBC:	
24 hrs	52.10
48 hrs	73.51
72 hrs	93.69
10% RBC:	
24 hrs	40.14
48 hrs	73.72
72 hrs	91.64

From these results we say that the RBC mixtures are highly digestible, however, it should be noticed that the 20% RBC mixture showed a slightly higher digestibility % which reveals that RBC is highly digestible.

IV. Animal Acceptability Response

Consumption for the entire period. (See Table #6)

The total consumption for the 5 heifers during the 17 days where both mixtures were fed together, excluding the adaptation period and the period where only 20% RBC mixture was fed, were 95.5 lbs. of the 20% RBC mixture; 284 lbs of the 10% RBC mixture.

The average consumption/head/day was:

1.09 lbs/an./day for the 20% RBC mixture
3.34 " " " for the 10% RBC mixture

These values were analyzed statistically (T test),

Table #6

INTAKE TABLE.

Adaptation period (only 10% R.B.C. mixture)
Consumption recorded in lbs.

Animal #	Day: 1	2	3	4	5	6	7
1, 2, 3, 4, 5,	1	2	3	4	4	4	4 (lbs.)

Trial period (3lbs./animal/day of each mixture fed.)

Day:	8		9		10		11		12		13		14		15		16	
Animal #	10%	20%	10%	20%	10%	20%	10%	20%	10%	20%	10%	20%	10%	20%	10%	20%	10%	20%
1	3.0	2.25	2.25	3.0	3.0	1.75	3.0	1.25	3.0	1.0	3.0	3.0	2.75	3.0	3.0	3.0	3.0	2.75
2	1.5	0	2.75	0	2.75	.25	3.0	0	2.75	.5	3.0	.25	3.0	.5	3.0	.25	3.0	.25
3	2.5	1.25	2.0	2.0	.5	2.25	2.0	1.75	2.5	2.25	1.0	1.75	2.0	2.0	2.75	2.5	2.25	2.25
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	2.5	.0	3.0	0	2.75	0	2.5	0	3.0	.75	2.0	3.0	.75	3.0	1.5	3.0	1.5	2.75

Table #6 (continue.)

Trial period (10% R.B.C. unabailable): limit to 4 lbs./animal/day/mixture.

Day:	17		18		19		20		21	22	23
Animal #	Mol.	20%	Mol.	20%	Mol.	20%	Mol.	20%	20%	20%	20%
1	4.0	4.0	4.0	4.0	4.0	4.0	4.0	3.5	4.0	4.0	4.0
2	4.0	.25	4.0	0	4.0	0	4.0	0	1.0	3.25	4.0
3	.5	4.0	2.0	3.75	2.75	2.5	2.75	3.0	3.5	4.0	4.0
4	4.0	1.0	4.0	0	4.0	0	4.0	0	0	0	0
5	4.0	.75	4.0	0	4.0	0	4.0	0	0	2.0	3.5

Trial period (day 24, 4 lbs./an./day/mixture, from then on, they had as much as they wanted to consume.)

Day:	24		25		26		27		28		29		30		31	
Animal #	10%	20%	10%	20%	10%	20%	10%	20%	10%	20%	10%	20%	10%	20%	10%	20%
1	4.0	2.0	5.0	1.25	6.0	2.75	7.0	1.75	7.0	.5	3.0	4.5	5.0	5.0	5.0	2.0
2	4.0	0	5.0	.5	6.0	.5	6.25	0	5.5	0	5.5	0	5.5	0	6.5	.5
3	1.0	2.0	2.75	1.5	5.0	.5	3.5	0	5.5	0	3.0	1.0	4.5	.5	4.0	0
4	2.25	0	4.75	0	5.0	0	6.0	0	5.5	0	4.0	1.25	5.5	0	5.5	.5
5	4.0	2.0	4.5	1.0	4.75	1.0	5.5	.5	6.0	1.0	6.75	0	5.0	5.0	6.0	0

concluding that there is a significant difference at the .01 level between the consumption of 10% and 20% RBC blends by the heifers.

During the period when molasses was fed against the 20% RBC blend, total preference was shown toward plain molasses (Consumption table), which indicates the high molasses acceptability by cattle.

The consumption table also shows the results of the consumption of the 20% RBC misture, which shows that the consumption rate/head can be increased by not offering cattle another more palatable supplement.

Scouring was not a problem during the trial. However, the average consumption could have been greater if one heifer had consumed her portion more constantly. She was off-feed for 9 days.

It can also be noticed that during the last 8 days of the trial, consumption per head increased considerably.

Summary and Conclusion

The research was planned to determine the stability, feeding acceptance and response of Red Blood Cells incorporated in a liquid supplement for cattle.

The two mixtures, the 10% RBC and 20% RBC blends, showed good stability, especially the 10% RBC. The shelf life on both samples seems to be adequate time for the mixture to be in an unspoiled and stable condition, from the time it is to be manufactured until fed. This 8 week period was tested under relatively low temperatures, which means that more research will be needed at temperatures above 70° F.

It can also be considered to increase the phosphoric acid content to increase shelf life and phosphorous content. We should also keep in mind that there are some molasses that gel when combined with phosphoric acid, which will obligate the manufacturer to check the molasses before any mixing can take place.

It was also shown that there is a significant difference ($P < .01$) between the consumption of 10% RBC mixture and the 20% RBC misture. When the heifers had no other choice than the 20% RBC, however, there was adequate consumption of this mixture.

Unfortunately the last phase of this research was not determined for reasons already mentioned. I feel that the Animal Response Trial should be performed before any other further steps are taken in order to make this in-

formation gathered useful for practical uses. Remember that how fast and how much the animals gain in weight with these supplements are important factors from our economic standpoint.

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