FEEDING AND SUPPLEMENTING PRICKLY PEAR CACTUS TO BEEF CATTLE

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INTRODUCTION

Prickly pear cactus (*Opuntia* spp.), a succulent plant native to the western hemisphere is a main stay in the diets of people, wildlife and domestic livestock (Benson 1982), (Cabeza de Vaca 1984), (Griffiths and Hare 1907a), (Lopez Gonzalez 1990), (Russell and Felker 1987) and (Varner et al 1977).

Rainfall is extremely varied and unpredictable in the South Texas ecosystem. Drought is inevitable (Drawe 1986), (Le Houerou and Norwine 1985), (Norwine and Bingham 1986).

During times of prolonged drought, feed values and nutritional content of most available plants diminish and the range diet of beef cattle should be supplemented. Over the past five years prolonged drought has reduced copper, zinc, manganese and selenium content from 50 to 75% in hay samples from four states in the intermountain west area (Greene et al 1983), (Griffiths 1905, 1910, 1920), (Morrison 1951), (Olsen 1991), (Shoop et al 1977), and (Thornber 1911).

Highly valued in times of drought and scarcity of water, prickly pear has been fed to cattle in northern Mexico and the southwestern United States since their introduction (Griffiths 1905,1910,and 1920), (Kilgore 1983), (Lopez Gonzalez 1990), (Russell 1986), and (Russell and Felker 1987).

Prickly pear is an economical source of cattle forage and is frequently used in semiarid zones by ranchers and dairymen that have difficulty in producing more conventional crops (Andre 1991), (Griffiths 1906 and 1920), (Gonzalez and Everitt 1990), (Lopez Gonzalez 1990), (Martinez Medina), (Woodward and Turner 1915), (Kay and Kay 1990),(Russell 1986).

Usually, to make the pads more palatable and accessible to cattle,thorns are now burned from the standing prickly pear cactus plants with the flame of a propane pear burner. Prickly pear pads can be chopped into smaller pieces and fed in troughs (Griffiths 1906), (Maltsberger 1989) and (Sibley 1989).

On a dry matter basis, prickly pear cactus is similar to immature corn silage in nutritional value. Cattle can consume 10% or more of their body weight in prickly pear per day (Hare 1908), (NRC 1971, 1981, 1982, and 1984), (Woodward et al 1915).

High in digestible dry matter (Varner, et al 1977), Vitamin "A", Calcium, Magnesium, Potassium, Sulfur and moisture content, prickly pear is low in protein, Phosphorus and Sodium. (Exhibit "B"), (Gonzalez and Everitt 1990), (Griffiths and Hare, 1907b), (Griffiths and Hare 1908), (Hare 1908), (NRC 1971, 1981, 1982, 1984), (Woodward and Turner 1915).

Of Crassulacean acid metabolism (CAM), prickly pear cactus opens it's stomata at night to take in carbon dioxide that is incorporated into organic acids and usually closes them during the day to conserve moisture. Net acid accumulation of the younger pads is high in the early morning hours and lessens throughout the day as the stored organic acids are converted into sugars by the cactus's CAM physiological process (Gibson and Nobel 1986), (Nobel 1988, and 1991) and (Samish, et al 1975).

Because of it's crassulacean acid metabolism features, prickly pear is able to produce from four to nine times more dry matter with a given amount of water than other plants grown in the area (Nobel 1985, 1988 and 1989), and (Russell and Felker 1987).

This paper is a discussion of feeding and supplementing prickly pear cactus to beef cattle. Animal health, mineral and protein supplementation will be addressed. It is imperative that cattle be kept in good health and their proper mineral and nutritional balances maintained to insure normal growth and reproduction under adverse conditions.

Study Area and Methods

Blood and tissue samples used for testing were taken from Santa Gertrudis Cattle on the La Salle County headquarters division of Maltsberger Ranch. The prickly pear sample came from the headquarter's waterlot, a Randado fine sandy loam soil of a shallow sandy loam range site.

In 1988, we started questioning many of the age old excuses heard in the South Texas Ranching industry. No longer can we be satisfied justifying poor animal performance as the product of drought. Deformities and diseases aggravated by malnutrition are not acceptable. (Allcroft and Uvarou 1959), (Andrews and Sinclair, undated), (Arnold and Becker 1936), (Bentley and Phillips 1951), (Black et al 1943), (De Boer et al 1981), (Dowe et al 1957), (Huisingh et al 1973), (NRC 1980,1984, and 1988) and (Rojas et al 1965).

To maximize production and define management problems in our ranching operation we sampled the blood of cows that lost their calves, cows that gave birth to weak or deficient calves and cattle that did not grow, breed or conceive in the manner expected.

Through the services of our veterinarian, Dr. John Clader, Chaparral Veterinary Center, Jourdanton, Texas and the Texas Veterinary Medical Diagnostic Laboratory at

College Station, Texas we found exposures in our cattle from Bluetongue, IBR, and Leptospirosis.

We started worming all of our cattle twice a year with Ivermectin, and giving annual immunizations to them with seven-way Blackleg, IBR-BVD. LEPTO-VIBRIO and Trichomonas foetus vaccines. During our regular cattle workings, when green forage is scarce we give each animal a Vitamin "A","D3" and "B12" injection.

In March 1990 we expanded our testing to include macro and trace minerals. We were in a drought and our cattle had been on burned prickly pear and cottonseed cake for thirty-nine months. We found our cattle were high in Calcium, Magnesium and possibly Selenium. Blood and tissue tests also indicated they were low in Copper, Molybdenum and Zinc. The Texas Veterinary Medical Diagnostic Laboratory is not able to test for Manganese or Iodine deficiencies at this time. Both are trace elements of concern in this area. We need to know more about Molybdenum. It's abundance or absence can be very influential in both plant and animal performance. (Andrews and Sinclair, undated), (Anderson 1956), (Bentley and Phillips 1951), (De Beor et al 1981), (Huisingh et al 1973), (NRC 1980,1984, and 1988), (Rojas et al 1965).

We feed a free choice bonemeal, meat scraps and salt mixture to supply our cattle with adequate levels of Phosphorus and Sodium (Arnold et al 1936), (Black et al 1943) and (Dowe et al 1957). In May 1991, Dr. L. W. Greene, Animal Nutrition Department, Texas A. & M. University, College Station, Texas formulated trace mineral additions to our bonemeal mix that will enable us to feed a single composite mineral supplement to our cattle. Based on results from blood and tissue tests run on our cattle and a chemical analysis of prickly pear cactus growing at our ranch, this formulation adds Zinc, Manganese, Copper, Iodine and Cobalt to our bonemeal mix (Exhibit "A"), (Exhibit "B").

In any group, a few cattle may not consume enough of our free choice mineral supplement to meet their need of Copper. In June 1991, to insure that future copper requirements necessary for growth, reproduction and lactation are met, we began the quarterly administration of "Molycu", a cupric glycinate injection marketed by Schering Corporation, U.S.A.. The injection gave positive results in our cattle (Allcroft and Uvarov, 1959), (NRC 1984, 1988) as discussed later.

DISCUSSION

Feeding Prickly Pear

The laxative property of prickly pear cactus causes concern to those not familiar with it's use as a livestock forage. It is considered a minor consequence by stockmen accustomed to feeding cactus. An Israeli experiment concluded that if the amount of prickly pear in the diet is increased slowly cattle will adjust to the change with no problems (Toledano and Katznelson 1972). Regulation of fecal material moisture content is possible.

After reviewing the literature on feeding Sisal, another CAM plant, it appears prickly pear's laxative effect on cattle is probably due to a lack of dry matter in the diet and prickly pear's high magnesium content. Trace mineral deficiencies may be complicatedby prickly pear's high content of Calcium, Sulfur and Magnesium (De Boer et al 1981),(Exhibit "B"), (Harrison 1985), (Huber 1976), (Huisingh 1973), (Nobel 1988),(NRC 1971, 1980,1981,1982,1984, and 1988).

Age, moisture content of the cactus and the time of day the ration is prepared can influence prickly pear's acid content as well as the digestive process of cattle being fed (Samish and Ellern 1975) and (Nobel 1988). As with most high moisture feeds, the ruminant consuming prickly pear cactus should, if possible, receive an additional source of dry matter equating from .5 to 1 per cent of the animal's body weight (Bath, et al 1980). In pasture situations, browse and dry grass will usually suffice.

Mineral Supplementation

Proper mineral balance is essential. Extensive experimentation with phosphorus supplementation was carried out on the King Ranch in the 1940's (Black et al 1943). Very little work has been done in South Texas on trace minerals.

Mineral content of dead tissue is usually less than live tissue. Nutritional quality most often peaks in the spring and declines during the winter dormancy and the hot summer months (Greene et al 1987), (Barnes et al 1990), (Varner et al. 1977). During drought, and as plants die or remain dormant for long periods of time, nutritional quality and mineral content decline (Olsen 1991).

The more adverse our range conditions, the more essential trace mineral supplementation becomes. Called trace minerals because such small amounts are needed, they are no less essential than the more familiar macrominerals (Exhibit "A").

The principle of limiting factors applies to animal nutrition. Until the least available limiting need is met, improvement in condition and the process of reproduction can not advance. For example, following calving, a cow will not cycle and breed back until enough cobalt is available in her system. A cow in good condition, and possessing a proper mineral and nutritional balance, has the potential to cycle and breed back in a relatively short time. If her body store of Cobalt is less than required, she will not cycle nor conceive until proper mineral balance is restored. Whether the process takes months or even years, it makes no difference.

During times of drought, without supplementation, mineral replacement may not happen until after rains come and plants grow. When a cow's store of an essential trace mineral is depleted, she will crash.

Cobalt, Copper, Iodine, Manganese, or Zinc can all affect reproduction. Deficiencies can cause still births and may cause small, weak, or deformed calves to be born. Deficient cattle may be "unthrifty" in condition, their skin may be dry and scaly, hooves may crack, bones may be brittle and break. In deficient calves pasterns may be weak and knuckle over, proper immunities may not be developed from vaccines, joints may be enlarged and scours or navel infections may be present. (Allcroft and Uvarov 1959), (Bentley and Phillips 1951), (NRC 1984, 1988), (Rojas et al 1965).

Cattle can appear to be in good condition and still suffer from subclinical deficiencies that keep them from breeding or cause them to give birth to defective calves. Some plants and feed products may effect Iodine or other trace mineral availability adversely causing deficiencies. (Andrews et al), (Hemken 1970), (Huising et al 1973) and (NRC 1980, 1984, and 1988).

Most commercially available mineral mixes are not formulated for South Texas and may not supply enough of the deficient elements. It is possible some might over supply unneeded Calcium, Magnesium, Potassium, Sulfur or Selenium. Too much of one mineral may adversely effect the consuming animal or affect it's ability to utilize other minerals. (De Boer et al 1981), (Dowe et al 1957), (Hemken 1970), (Huising et al 1973), (NRC 1980, 1984, 1988).

Trace mineral content of feed stuffs may vary according to point of origin (Olsen 1991). I believe we have over fed cottonseed products in the past for their trace mineral content, not recognizing the cause of improvement in our animal's condition.

The copper injections given in June delayed our anticipated need to start supplemental feeding of our cattle this summer by at least one month. Calves born a month after their dam's injection were larger, stronger, more alert, had stronger nursing reflexes and are in better health. Appearance of "thrift" in our cattle improved rapidly, after the copper injection.

Protein Supplementation

Crude protein, as stated in the chemical analysis of most feeds and supplements, is nothing more than an expression of nitrogen content. True or usable protein content may be quite different. A specific protein supplement's value in a ration will depend upon it's availability to, and point of digestion, by the consuming host (Benjamin 1980), (Cole et al 1976), (Coppock 1989), (Erdman et al 1987), (NRC 1984,1985 and 1988).

A deficiency of molybdenum in the soil can cause a lessening of the amount of protein and an increase in nitrogen stored by plants (Anderson 1956). Low protein in the diet of a ruminant can also cause a copper deficiency.

Non Protein Nitrogen (NPN) is converted to ammonia in the rumen and synthesized into bacterial protein. The production potential of bacterial protein in the rumen is limited. Excess unsynthesized ammonia escapes the rumen in a gaseous form and is lost. Usually only enough protein is produced in the rumen for maintenance. Gain, growth, reproduction and lactation all have greater protein requirements that must be derived from sources not degraded by rumen fermentation. (Chalupa 1975), (Ensminger and Olentine 1978) and (NRC 1984, 1985 and 1988).

Protein sources that are not totally degraded in the rumen fermentation process, passing on into the omasum and abomasum, are called bypass protein. Bypass protein is of greater value in producing gain and in the ruminant's production functions other than maintenance (Chalupa 1975), (Coppock 1989), (Ensiminger and Olentine 1978) and (NRC 1984, 1985 and 1988).

Results were unsatisfactory when Urea, a source of NPN, was used as a supplement in feeding Sisal. Gain improved when bypass protein sources of higher quality were used in the rations (Harrison 1985).

As needed or limited by constraints of economics, availability and nutrition, other roughage, concentrate and protein sources may be fed with prickly pear cactus.

Historically cottonseed products, because of availability and quality, have been the protein supplements of choice when feeding prickly pear to cattle in South Texas (Maltsberger 1989).

Exhibit "A"

RECOMMENDED MINERAL SUPPLEMENT FOR MALTSBERGER RANCH

La Salle County, Texas

May 17, 1991

(Calcium-Phosphorus-Sodium-Trace Mineral Composite) *

Ingredients	Amounts (lbs.)
Bonemeal, steamed	1,000.00
Meat and Bonemeal	330.00
Salt	613.70
Zinc Sulfate	27.00
Manganese Sulfate	17.00
Copper Sulfate	12.00
Ethylenediamine Dihydriodide	.20
Cobalt Sulfate	.10
Total	2,000.00 *

This mixture was prepared by Big-Tex Grain, San Antonio, Texas. Consumption may be limited to .2 lbs per animal day by mixing with plain white stock salt at the mineral feeder.

Exhibit "B"

Accession #: A90253049

TEXAS VETERINARY MEDICAL DIAGNOSTIC LABORATORY

P. O. Box 3200, Amarillo, Texas 79116-3200

***TOXICOLOGY - LAB RESULTS 9/18/90

Animal/Specimen ID: Prickly Pear Cactus (Opuntia Spp.) *

Specimen	Test/ID	Quantity	Units
Plant	Moisture	88.74	%
	Crude Protein	04.85	%
	Ash	19.80	%
	Fat	03.86	%
	Nitrogen Free Extract	51.87	%
	Carbohydrates	71.49	%
	Calcium	5.15	%
	Sulphur	0.32	%
	Phosphorus	0.05	%
	Total Digestible Nutrients	71.96	%
	Acid Detergent Fiber	19.66	%
	Digestible Protein	01.03	%
	Magnesium	01.49	PPM
	Molybdenum	00.21	PPM
	Copper	17.00	PPM
	Selenium	00.055	PPM
	Zinc	15.00	PPM

This prickly pear cactus sample came from the Maltsberger Ranch Headquarter's water lot. It was growing on a Randado fine sandy loam soil of a shallow sandy loam range site. The sample was "fat" from recent rain and probably shows a higher than normal moisture content. Dry matter content in the Griffiths and Hare 1907 and 1908 work on similar varieties averaged about 17.3 %.

* Taxonomically this specimen most closely fits with those grouped under *Opuntia lindheimeri* var. *lindheimeri* (Benson 1982).

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