UNIVERSITI PUTRA MALAYSIA

STUDIES ON THE UTILIZATION AND SUPPLEMENTATION OF SWEET CORN STOVER SILAGE AND ITS EFFECT ON CARCASS COMPOSITION OF GROWING LAMBS

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By

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Chairman: Assoc. Prof. Dr. Mohamad Hilmi. Hj. Abdullah

Faculty: Veterinary Medicine and Animal Science

The main objectives of this study are to determine the growth performance and carcass composition of growing lambs raised on sweet corn stover silage.

The sweet corn stover can be considered to be a better quality animal feed as indicated by its high crude protein content and its low neutral detergent fibre, acid detergent fibre and acid detergent lignin as compared to other cereal crop straws. The nutrient content of the sweet corn stover could be maintained by ensiling. The ensiling process takes four weeks and the silage can be stored for 16 weeks without any change to its nutritive value. When rice bran is added to the ensiling, the crude protein and the potential degradability increase. However, addition of molasses only increased potential degradability but decreased crude protein content.

The total intake of sweet corn stover silage by growing lambs was 24.2 g dry matter/kg body weight. The concentration of rumen ammonia was 229.2 mg N/l and the total volatile fatty acids was 63.1 mM/l. With concentrate supplementation (200 g/animal/day; 20 - 30% crude protein, fish or soybean meals as source of

protein) on the sweet corn stover silage basal diet, the total dry matter intake increased (29.0%), however, dry matter intake of sweet corn stover silage decreased (13.6%). The concentrate supplementation also increased rumen ammonia (28.1%) and total volatile fatty acids (5.5%).

Providing 100% of the sweet corn stover silage to the lambs was sufficient for maintenance as well as for a little average daily gain (10.7 g/day) with a dressing percentage of 42.5%, carcass fat of 3.3% and lean to bone ratio of 1.86:1. The concentrate supplementation increased the average daily gain to 71.6 g/day, the dressing percentage to 47.7%, the carcass fat to 8.3% and the lean to bone ratio to 2.8:1.

Fish meal or soya bean meal as a source of protein supplementation had a similar effect on the nutritive values, growth rate and carcass composition.

Abstrak tesis yang dikemukakan kepada Senat Universiti Pertanian Malaysia sebagai memenuhi syarat keperluan untuk Ijazah Master Sains

KAJIAN KE ATAS PENGGUNAAN DAN SUPPLEMENTASI SILAJ JERAMI JAGUNG MANIS DAN KESANNYA KE ATAS KOMPOSISI KARKAS BEBIRI YANG SEDANG MEMBESAR

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Pengerusi: Prof. Madya. Dr. Mohammad Hilmi. Hj. Abdullah

Fakulti: Kedoktoran Veterinar dan Sains Peternakan

Objektif utama kajian ini adalah untuk menentukan prestasi pertumbuhan dan komposisi karkas bebiri yang sedang membesar dan diberi pemakanan silaj jerami jagung manis

Jerami jagung manis boleh dianggap sebagai makanan ternakan yang mempunyai kualiti yang baik, iaitu tinggi dalam kandungan protein kasar dan rendah dalam kandungan neutral detergen fiber, asid detergen fiber dan asid detergen lignin berbanding kepada jerami tanaman bijirin lain. Kandungan nutrien daripada jerami jagung manis ini dapat dipertahankan dengan proses fermentasi. Proses pemasaman adalah empat minggu sahaja dan silaj ini dapat disimpan dalam selama 16 minggu tanpa sebarang perubahan pada nutriennya. Jika dedak padi ditambahkan pada masa fermentasi, kandungan protein kasar dan keupayaan pendegradan akan meningkat, manakala penambahan molases hanya meningkatkan keupayaan pendegradan sahaja sedangkan kandungan protein kasar menurun.

Jumlah pengambilan silaj jerami jagung manis oleh bebiri yang sedang membesar adalah 24.2 g bahan kering/kg berat badan. Konsentrasi rumen ammonia dan asid lemak meruap keseluruhannya masing-masing adalah 229.2 mg N/l dan 63.1 mM/l. Dengan penambahan makanan tambahan (200 g/ekor/hari, kandungan protein kasar antara 20 - 30%, tepung hampas kacang soya atau tepung ikan sebagai sumber protein) kepada makanan asas, pengambilan bahan kering meningkat (29.0%). Walau bagaimana pun ianya menurunkan pengambilan bahan kering dari silaj (13.6%). Konsentrasi dari pada rumen ammonia dan jumlah asid lemak meruap juga meningkat dengan makanan tambahan masing-masing sebanyak 28.1% dan 5.5%.

Pemberian 100% silaj jerami jagung manis hanya mencukupi keperluan saraan dan meningkatkan sedikit purata pertambahan harian (10.7 g/hari) dengan peratusan karkas (42.5%), lemak karkas (3.3%) dan nisbah daging dengan tulang (1.86:1). Penambahan dengan konsentrat, meningkatkan purata pertambahan harian kepada 71.6 g/hari), peratusan karkas kepada 47.7%, lemak karkas kepada 8.3% dan nisbah daging dengan tulang kepada 2.8:1.

Tepung hampas kacang soya dan tepung ikan sebagai sumber protein tambahan mempunyai kesan yang sama ke atas nilai pemakanan, pertumbuhan dan ciri-ciri karkas daripada bebiri yang sedang membesar yang memakan silaj jerami jagung manis.

CHAPTER I

INTRODUCTION

Efficiency of livestock production depends greatly on sufficient feed of the right quality and its availability throughout the year. The potential of animal production depends critically on feed energy and protein resources (Sykes, 1992). Devendra (1991) reviewed the availability of feed resources in the Asian region and identified the importance of permanent pasture and crop residues.

In South East Asia, the productivity of ruminant livestock is extremely low due to its traditional management system, poor nutritional status and, to some extent, poor disease control especially in the rural areas. In Malaysia, as in most of the Asian countries, ruminants are still raised under traditional system. The animals are let to graze on the forages growing along the road sides, on unused lands, and sometimes in the rice fields after the harvesting period. During the rainy season, the supply of green forages are generally sufficient, but during dry season the supplies are limited. The success or failure of livestock enterprise in Malaysia depends mainly on the availability of feed, particularly during dry season, when little or no grass grows.

With the advancement of agricultural technology, most of the arable agricultural lands are fully utilized. In modern rice production systems, the rice fields are not left idle but are cultivated with other cash crops such as corn, sweet potato and tobacco. With limited areas available for grazing, more and more

farmers are forced to practice cut and carry system or to feed their animals with commercial feeds. However, the cost of commercial feeds is high. Since most of the ingredients are imported, the cost of the commercial feed becomes too expensive and is not economically viable for smallholder farmers. Therefore, a cheaper ruminant feed as an alternative, which is not directly in competition with human consumption is necessary. Since most of agricultural activities in Malaysia are based on intensive crop production, a variety of crop residues are available as feed for ruminants. These by-products include rice straw, corn stover, sugar cane bagasse, sugar cane tops, etc. Some of these feeds, such as rice straw, are traditionally used by farmers to feed their animals.

Generally, fibrous crop residues are characterized by extensive lignification of cellulose and hemicellulose, and by low level of protein, soluble carbohydrates and mineral (Dixon, 1986). These characteristics are caused by the changes in cell wall content due to the increase in maturity. Weaver (1978) stated that increasing maturity will not only increase cell wall percentage, but also decreases the digestibility of cell wall. McManus (1983) determined that the decrease in digestibility of cell wall was caused by substances masking cell wall structures which prevented the action of microorganisms and enzymes upon the substrates within the cell. Moreover, McManus (1983) said that masking substances were lignin, hemicellulose and certain protein. He showed that the masking substances are enhanced by mineralization of silica in external layers of the cell wall. Some of the crop residues like corn stover, although abundantly available, are unused and left in the field. According to Carangal and Calub (1987), and McDonald et al. (1987), the corn stover has a high nutrient content and is more digestible than other cereal crop residues. McDonald et al. (1987) reported that corn stover has crude

protein of about 60 g/kg DM and a metabolizable energy (ME) value of about 9 MJ/kg DM. Rivera et al. (1989c) reported that the average daily gain of calves grazing on corn stover field at 2.71 stocking rate (head/ha) was 0.513 kg/day.

Corn stover is one of the major crop residues in Malaysia. Sweet corn was first introduced to small farmers by Malaysian Agricultural Research and Develpoment Institute (MARDI) in 1981. It replaced most of the traditional cultivar of boiling corn (Ramli and Zameri, 1983). As a result, the area of sweet corn cultivation in Peninsular Malaysia in 1989 increased to 7,116 ha (Kementerian Pertanian Malaysia, 1989). In harvesting sweet corn, ears are picked before they are fully ripe and the partly green stover are left in the field to decompose or are cut down and removed from the field. The land may be prepared for other crops. Approximately, 40 to 50% of corn plant dry matter remains in the residues after harvesting (Berger et al., 1979). Like many bulky crop residues in Malaysia, the collection and storage of corn stover are major constraints in their utilization for livestock feeds. The storage of dry stover requires a large area and space because of its bulkiness and requires care because they present a high fire hazard. The other method of preserving corn stover is by ensiling (Isarakul, 1982; Castillo, 1983).

The efficiency of animal production raised on crop residues is not only determined by availability and continuity of their supply, but is also basically determined by its nutritive values, digestibility and their effect on growth performance and carcass composition. Even though a lot of research on corn stover as animal feed has been done, the local work on the use of sweet corn stover silage as feed are few. The nutritive value, intake, digestibility of sweet corn stover silage and its effect on growth performance and carcass composition of growing lamb are still not fully established.

The main objectives of this study are to determine growth performance and carcass composition of growing lambs raised on sweet corn stover silage. The specific objectives are as follows:

i. To determine the chemical composition of sweet corn stover fraction and sweet corn stover silage.

ii. To determine the degradability of sweet corn stover fraction and sweet corn stover silage.

iii. To determine the intake and digestibility of sweet corn stover silage supplemented with different sources and levels of protein.

iv. To determine the effect of different sources and levels of protein supplementation of sweet corn stover silage basal diets on rumen pH, ammonia and VFAs concentration.

v. To determine the effect of different sources and levels of protein supplementation of sweet corn stover silage basal diets on growth performance of growing lambs.

vi. To determine the effect of different sources and levels of protein supplementation of sweet corn stover silage basal diets on carcass composition of growing lambs.

CHAPTER II

LITERATURE REVIEW

The majority of farmers in the Asian region are involved in mixed farming system. In general, smallholder farmers have small area of land (1-2 ha). They usually diversify their activities to maximize income from the land. Many farmers keep livestock as integral part of the farm. The animals are kept for home consumption, insurance against crop failure and for the production of manure. The majority of ruminants in Malaysia are raised under traditional management system. The animals are allowed to graze on waste or unused land during the day and are kept at night in simple pens or sheds. During the dry season green forages are limited and most farmers feed their ruminant with crop residues such as rice straw, sugar cane tops, etc.

Crop Residues as Ruminant Feed

Ruminant animals have a stomach with four compartments, namely rumen, reticulum, omasum and abomasum. The rumen acts as a large fermentation vat and has a very high population of microorganisms (Church and Pond, 1978). Unlike monogastric animals, ruminant animals are able to digest low quality roughage to volatile fatty acid as source of energy by using microorganisms (McDonald et al., 1987). By fermentation, the ruminant converts the crop residues, which are not digestible for human, to very nutritious and palatable human foods, meat and milk.

Crop residues are major source of feeds for ruminant in South East Asia, particularly in area where land for grazing is limited and pasture growth is seasonal (Dixon and Egan, 1988). Carangal and Calub (1987) mentioned that the most common crop residues used as ruminant feed are rice straw, corn stover, barley straw, soybean straw and peanut straw. In most Asian countries, rice straw and corn stover are the most importance crop residues for animal feeding particularly during the dry season (Castillo, 1983; Carangal and Calub, 1987). Among the cereal straw, corn stover has a higher crude protein content than the other cereal straw (McDonald et al., 1987; Carangal and Calub, 1987; Castillo, 1983). Currently, utilization of corn residues as animal feed are on the increase. For instance in the United State, residues from corn cultivation, such as stover is half of the total available residue supply. These materials can be a useful source of winter feed for beef cattle (National Research Council (NRC), 1983). Table 1 summarizes some studies carried out on the utilization of corn stover.

There are many corn varieties frequently planted by farmers to produce grain, young cob and baby corn. Gebencsikop (1949) as cited by Singh (1987) introduced the term corn varieties (varieties groups) to designate the maize type viz: Flint maize, Dent maize, Pop maize, Floury maize, Pod maize, and sweet maize (*Zea mays* cornvar. *Saccharata* Koern.).

Table 1

Utilization of Corn Stover as Animal Feed

Reference	Level	Suppl. status	Corn stover intake	Digestibility	Live weigh gain (kg/d)	Animal
Rivera et al., 1989a	gazing 2.71 h/ha	n.a.	n.a.	n.a.	0.513	cattle
Rivera et al., 1989b	grazing					
	2 week	n.a.	n.a.	DMO 57-75%	n.a.	cattle
	8 week	n.a.	n.a.	DMD 41-58%	n.a.	cattle
Van der Liden et al., 1984	*ad lib.*	pelleting protein	21.9 g/kg W.	OMD 14.0 g	n.a.	sheep
	ad lib.	pelleting protein+ corn grain	16.3 g/kg W.	OMD 13.9 g	n.a.	sheep
Colenbrander et al., 1971	*ad lib.*	supple-mented	4.25 kg/d	n.a.	0.508	dairy heifer
Isarakul and Isarakul 1984	n.a.	n.a.	0.40 kg/d	OMD 59.0 %	n.a.	sheep
	n.a.	n.a.	3.13 kg/d	OMD 64.2 %	n.a.	cattle
	n.a.	n.a.	3.12 kg/d	OMD 62.5 %	n.a.	buffalo

n.a = not available

Cultivation of Sweet Corn in Malaysia

The sweet corn (sweet maize) crop is primarily grown for its tender green ear which is harvested at the milk stage. It is commonly consumed after boiling, however, it can also be canned or frozen for later consumption (Singh, 1987). Boiled corn cob (jagung) is a popular vegetable in the markets and roadside stalls in Malaysia. In 1981, the Thai super sweet cultivar was introduced in Malaysia by Malaysian Agricultural Research and Development Institute (MARDI). This cultivar has a soft and sweet kernel and it can be harvested 70 days after planting. The Thai super sweet has also replaced most of all the traditional cultivars (Ramli and Zameri, 1983). Statistical data issued by Kementerian Pertanian Malaysia showed that the hectares of sweet corn in 1989 was 7116 ha or about 84% of the total area of corn cultivation in Peninsular Malaysia. The distribution of sweet corn cultivation in this area is presented in Table 2.

Sweet corn is one of the important resources of fibrous crop residues in the tropical and sub tropical areas. In Thailand, sweet corn is often integrated with many cropping systems and grown in the dry season (Isarakul and Isarakul, 1984). The purpose of the corn cultivation is to produce young cobs. The cobs are usually picked up at the milky stage. At this stage, most of leaves and stalks are still green, which are good as a source of ruminant fodder.

Table 2

Area under Sweet Corn Cultivation (hectares) According to States and Years in Peninsular Malaysia

State	Years			
	1986	1987	1988	1989
Johor Darul Takzim	633	742	1288	1266
Kedah Darul Aman	325	373	489	654
Kelantan Darul Naim	67	819	1117	1082
Melaka	131	185	123	120
Negeri Sembilan Darul Kusus	37	104	52	141
Pahang Darul Makmur	327	578	396	714
Pulau Pinang	60	123	88	197
Perak Darul Ridzuan	926	1207	832	987
Perlis Indra Kayangan	61	289	334	178
Selangor Darul Ehsan	357	398	431	987
Terenganu Darul Iman	575	807	867	790
Semenanjung Malaysia (Total)	3599	5625	6017	7116
Fresh Corn stover weight (mt)*	67	104	112	132
Corn stover DM (mt)*	16	25	27	32

*Estimate
Source: Kementerian Pertanian Malaysia (1986,1987,1988,and 1989).

Corn Stover as Ruminant Feed.

There are two systems in which forages are utilized as animal feed, namely, grazing system and cut and carry system.

Grazing System

In this system, animals are allowed to graze corn stover in the field. This system is an economical method of utilizing corn stover, because it does not require the use of machine in harvesting and no material in removed from the soil (NRC, 1983). The grazing system can be profitable if the animal and corn stover are in the same location especially if they are within the same farm (Klopfenstein et al., 1987). Undoubtedly, the grazing system is the simplest and cheapest form of utilizing corn stover, but it has certain limitation. It was shown the corn stover tend to lose its nutritive value rapidly (Parra and Escobar, 1985). The reduction in nutritive value was caused by selected grazing (Rivera and Klopfenstein, 1989ab) and under grazing system, loss of soluble sugar and protein is related to the time the corn stover is left in the field.

Cut and Carry System

Another important method by which corn stover is utilized as an animal feed is by the cut and carry system. The stover is collected, transported, processed and finally fed to animals. This system is more costly, compared to the grazing system, but it is useful for animals under intensive system and has the advantage that its nutritive value is maintained.