

UTILIZATION OF FRUIT PROCESSING WASTE FOR FEEDLOT BEEF CATTLE DIETS

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Abstract

This article aims to evaluate the possibility of using by-products from the banana and pineapple processing industry as feed for feedlot ruminants farming, looking at the yield potential and nutritional value for ruminants.

Bananas and pineapples are important fruit trees in our country's export crop structure. The amount of by-products from these two crops is very large and has good nutritional value, and can be used in the diet of intensively raised ruminants. Replacing part of the ruminant diet with these by-products increases livestock efficiency and reduces production costs. Research into the processing and use of these by-products on a large scale can be applied in concentrated beef and dairy cattle farming models in our country to increase the competitiveness of the ruminant livestock industry.

Key words: diets, utilization, fruit, beef, cattle

Introduction

Changing production methods from small-scale farming to large-scale concentrated farm farming is becoming an urgent requirement for transformation in our country's livestock industry. In particular, ruminant livestock farming is also gradually shifting to a commodity production method with a scale of thousands to tens of thousands of animals per farm. This requires a huge amount of food to be supplied to farms every day, especially roughage. Intensive ruminant farms need to diversify the roughage sources by producing the roughage by themselves and purchasing from suppliers outside the farm. However, the yield and quality of roughage depends on the season, soil and harvesting time of each different geographical area.

Fruit production for export is gradually becoming an important sector in Vietnam's economic structure in general and the agricultural sector in particular. Production and processing of fruit for export also generates a large amount of by-products. These by-products have good nutritional value and have been proven by many studies to have the ability to be used as feed for ruminants. However, processing and preserving these by-products on a large scale to create goods to supply to concentrated ruminant farms is a big challenge, related to their nutritional value, nutrition, livestock efficiency, processing and preservation processes, logistics

This article aims to evaluate the possibility of using by-products from the banana and pineapple processing industry as feed for feedlot ruminants farming, looking at the yield potential and nutritional value for ruminants.

By-products processed from banana

In 2022, Vietnam will have about 154,000 hectares of banana-growing land, reaching a yield of 2.2 million tons of bananas per year. In 2022, banana exports will reach 310.6 million USD, becoming the fruit with the second-largest export value in the country. The banana industry produces a large amount of by-products including banana stems, leaves and residue banana fruits. The amount of bananas fruit discarded from the preliminary processing accounts for 20-40% of

the total banana yield (Kramer 2014). Banana leaves and banana fruits have suitable nutritional value for many livestock species and have been researched to be used as food for ruminants.

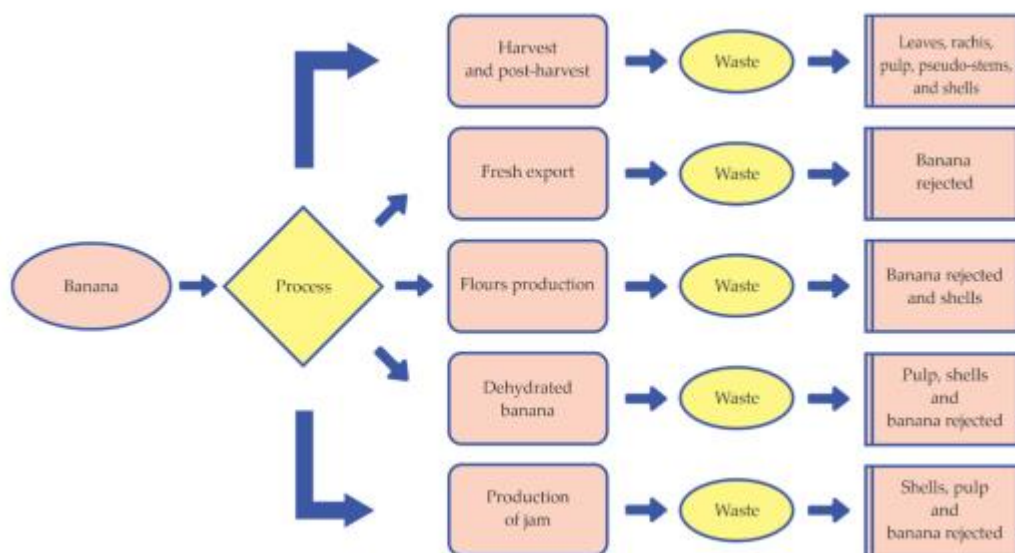


Figure 1. Scheme of production of waste-loss from the banana processing.
(Alzate Acevedo et al. 2021)

Banana leaves contain about 85% water and 10-17% DM protein. Banana stems contain mostly water (92-95%) and very little protein (3-4.5% DM). High fiber content, NDF in the range of 50-70% DM and ADF around 30-40% DM (Feedipedia, 2011). Banana leaves contain a large amount of total polyphenols (up to 8% DM), mainly in the leaves, but very little condense tannin.

Table 1: Chemical composition of banana part (Kramer 2014)

Chemical composition	Stems	Leaves	Green fruit
Dry matter, % fresh matter	97	21.6	18.0
Organic matter, % DM	83.6	85.2	94.4
Crude protein, % DM	2.6	10.4	5.3
Crude fat, % DM	5.9	-	-
NDF, % DM	56.7	61.3	28.3
ADF, % DM	42.7	34.9	5.5
Lignin, % DM	7.2	12.4	2.2
Ash, % DM	16.4	10.8	-

Banana leaves are a useful source of roughage in many tropical countries. In particular, it can be used as emergency feed in case of drought or feed shortage. Stems and leaves can be fed separately or mixed together. They can be fed fresh or dried in the sun, and chopped. Banana stems are easily fermented if chopped and mixed with a fermentable carbohydrate source such as molasses or rice bran. The silage is good quality. Banana leaves alone can not meet the animal's requirements and must be supplemented with nitrogen and energy, or as part of a diet containing other feeds and fodder

Bananas fruit contain large amounts of non-structural carbohydrates, mainly starch and sugar (85-93% DM). In green bananas, starch accounts for 65-75% of the DM. Bananas have a low crude protein (3% DM) and mineral (2-4% DM) content. Bananas contain a significant amount of tannin, which can affect the ability of animals to absorb food and digest food.

Digestive capacity and rumen decomposition capacity

There are significant differences in decomposition and digestibility between banana leaves and stems. Unlike other plants, the digestibility of the stem is higher (75%) than that of the leaves (65%) and the apparent digestibility of OM and DM is similar. The reason is believed to be due to the hardening of banana stems due to water retention in the cells, not due to the presence of high levels of lignin in the cell walls. The leaves' high tannin content may also explain their lower digestibility.

Table 2: Chemical composition of banana for ruminant

Nutrition composition	Leaves	Fruit	Peel
Digestive organic matter ratio, %	74	82	69,3
Digestive energy ratio, %	70,4	77,8	-
TDN for ruminant, MJ/kg DM	12,4	13,3	9,1
Digestive energy for ruminant, MJ/kg DM	9,9	11,3	-
Digestive nitrogen ratio, %	54,7	85	22

Bananas are considered a good source of energy for ruminants. The net energy value of a banana is equivalent to that of a barley grain. However, because bananas are poor in protein, minerals and fiber, it is necessary to combine the diet with protein-rich roughage foods or other protein-

Table 3: Effects of ensilage to the nutrition composition of banana leaves
(Wang et al. 2016)

Nutrition composition	Fresh leaves	Ensilage leaves (after 60 days)
Dry matter, % fresh matter	9,77	9,25
Water soluble carbohydrate, % DM	7,8	1,68
Crude protein, % DM	2,8	5,25
NDF, % DM	35,3	51,4
ADF, % DM	16,4	15,7
Total tannin, % DM	0,22	0,28
Condense tannin, % DM	0,18	0,17
pH		3,99
NH ₃ -N, % total N		14,5
Lactic acid, % DM		4,4
Acetic acid, % DM		1,1
Propionic acid, % DM		0,08
Butyric acid, % DM		0,04

rich food sources. Ensuring banana leaves is often used to preserve and increase the palatability of banana leaves.

Feed intake

Dry matter intake for banana stems is very low (13 g DM/day/kg body weight for Zebu cattle, 6.6 g/head/day for goats), possibly due to high humidity and their low protein content. The amount of DM for leaves was higher (23 g DM/day/kg body weight in Zebu cattle, 13.6 g/day/kg in goats, 20 g DM/day/kg in sheep).

Use in cattle diets

There have been many conclusive experiments on the positive effects of banana leaves when supplemented or used in a complete diet.

In beef diets, supplementing banana leaf powder up to 40% in forage diets increased weight gain and feed efficiency of Zebu cows and sheep (Garcia et al., 1973).

In growing calves, a 40:60 mixture of plantain stalks and corn silage reduced feed costs and increased digestibility, but DM intake and body weight decreased (Dormond et al., 2001). In the Seychelles, young Jersey cows fed chopped banana leaves and banana stems supplemented with urea/molasses and leucaena leaves had a growth rate of 0.4 kg/day (Preston et al., 1987). Weight gain of 0.5 to 0.7 kg/day was obtained in steers fed banana tops supplemented with molasses and urea (Rowe et al., 1978). In Zanzibar, banana forage can provide maintenance rations during the dry season and reasonable growth in barnyard animals when combined with other feeds (Reynolds et al., 1983).

Beef cattle have the ability to use diets containing 50-75% banana DM. Feeding 15kg of green bananas/day to grazing cows increases weight gain by 50% (0.4 -0.5 kg/day to 0.6-0.7 kg/day). Bananas increase weight gain in beef cattle but reduce feed costs in cows.

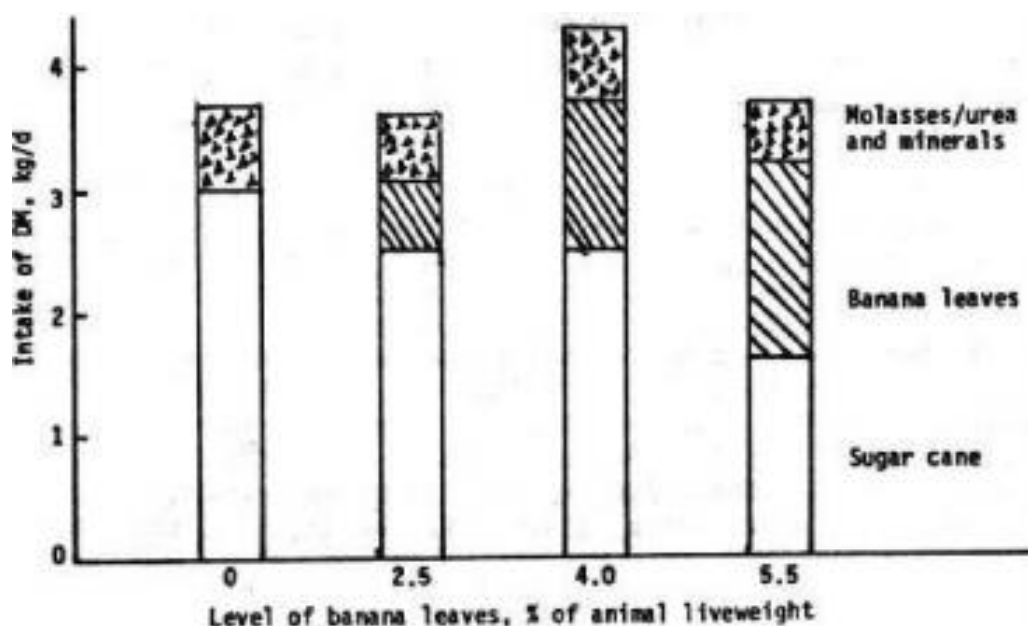


Figure 2: Effects of banana leaves ratio in diet to feed intake of Zebu cattle (Preston và Leng, 1987)

Dairy cow

Fresh banana leaves can be included at up to 15% (dietary DM) in the diet of milking cows without significantly changing milk yield, although yield and milk digestibility decrease when banana leaves increased in the diet (El-Ghani, 1999).

Ensuring banana leaves with other ingredients can be a valuable strategy. Banana leaf tops and wheat straw (75:25) incubated with molasses and urea can replace 50% of green maize in the diet of Red Sindhi cows without changing milk yield (Baloch et al., 1988). Banana leaf tops composted with broiler manure (40:60) and molasses or whey powder can be fed at 15% (DM of the diet) in the diet of lactating buffaloes and are well tolerated without adverse effects. bad for milk yield (Khattab et al., 2000).

Bananas can replace energy-providing ingredients in the diet of dairy cows. Bananas can replace 50% of grains in the diet of young cows.

By-products from pineapple processing

Vietnam is the country with the 10th highest pineapple production in the world in terms of the country's total pineapple growing area of about 34,642 hectares and output of 555,047 tons (FAO, 2016). The proportion of by-products from pineapple juice accounts for 65% of the total fruit yield (Gowda et al. 2015). Pineapple by-products have high moisture content (90%), rich in soluble carbohydrates (20-30% DM) mainly simple sugars, including sucrose, fructose and glucose (Heuzé et al. 2015). Pineapple residue is mainly used fresh or as silage in ruminant diets due to its short storage time (Gowda et al. 2015, Heuzé et al. 2015). Using silage by-products from pineapple increases feed intake, feed efficiency and weight gain of beef cattle (Mui 2004, Suksathit et al. 2011).

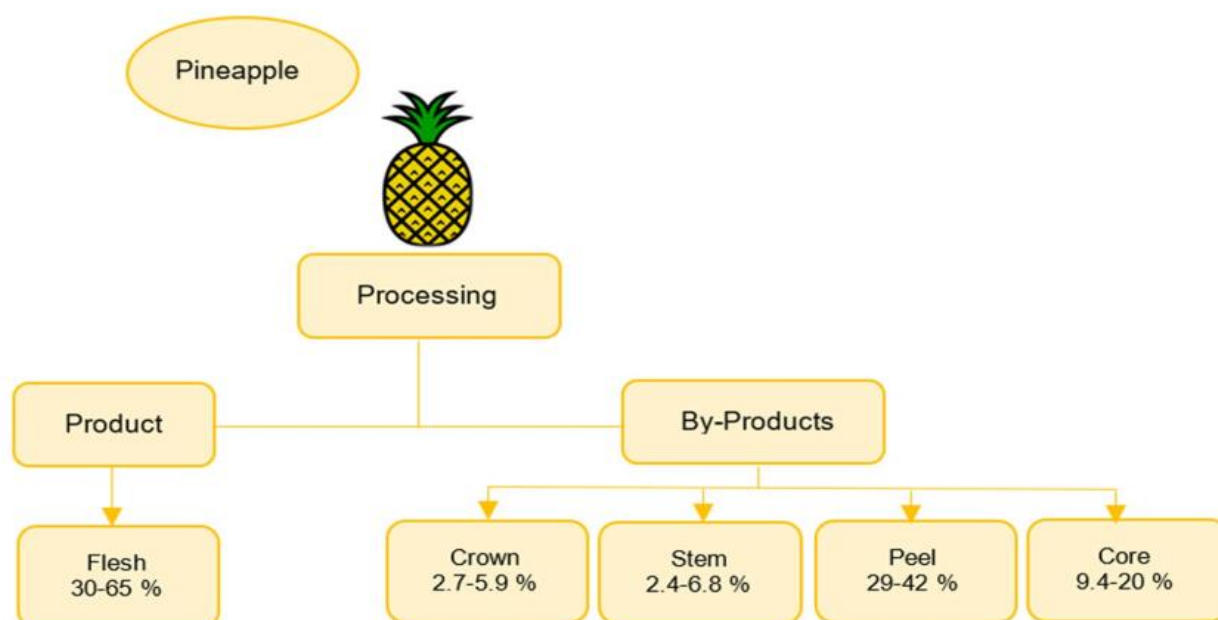


Figure 3: Main products produce from pineapple processing
(Polania et al. 2022)

Table 4. Nutrition composition of fermented pineapple waste (PAW)
(Sukri et al. 2023)

Nutrition composition	Fresh PAW	Fermented PAW
Âm độ, % fresh matter	91.35	72.49
Crude protein, % DM	10	0.91
Crude fiber, % DM	0.6	-
Crude fat, % DM	0.64	12.88
Soluble solid, % DM	10.2	27.51
Sugar loss ratio, %	8.2	5
Sugar remain ratio, %	8.8	1.7
Total sugar, %	10.	-
Ascobic acid, %	26.5	-

Using silaged pineapple by-products in TMR diets for beef cattle increases feed efficiency and weight gain of cows (Suksathit et al. 2011). Using pineapple by-products can increase the quality of fermented TMR diets (Nguyen Thi Ha Phuong et al., 2021). Replacing 10% of corn stalks with pineapple by-products does not affect the nutritional value of the TMR diet. Using pineapple by-products quickly reduces pH and limits mold growth during fermentation of TMR diets. Using 10% dry matter by-products from pineapple does not affect the intake and digestibility of dry matter and total organic matter but increases the ability to absorb protein, digestibility of protein and the ability to increase weight of goat. High soluble sugar content in pineapple by-products can change the fermentation behavior of FTMR diets during storage, indirectly changing the nutritional value of the diet.

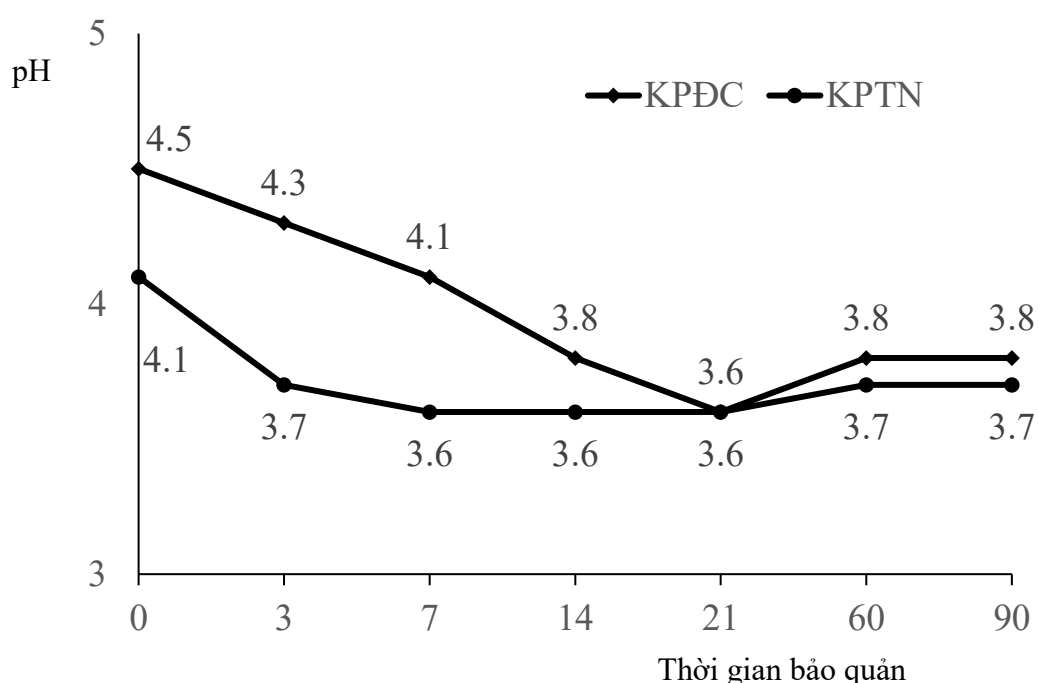


Figure 4 Effects of supplement pineapple waste on pH of fermented TMR diet

KPĐC: TMR diet including whole corn crop, rice straw, corn grain powder, soybean meal; KPTN was replace 10% DM of pineapple peel to whole corn fodder in KPĐC. Nguyen Thi Ha Phuong et al (2011)

In ruminant livestock farming, pineapple by-products (pineapple peel, pineapple pulp, pineapple stem and leaves) are used as a source of roughage in the diet. Using pineapple by-products tends to increase animal productivity and reduce production costs. Using pineapple by-products in dairy cows' diets increases milk production and milk quality. Silage of pineapple by-products increases the digestibility of the diet compared to grass silage. Furthermore, pineapple byproducts contain the enzyme bromelain, which has anti-inflammatory and antioxidant effects. Therefore, using pineapple by-products in the diet helps improve animal health. Using 30% dietary DM from pineapple peel increases albumin and blood Mg of dairy cows, but reduces blood urea, triglycerides, nonesterified fatty acids, acidosis and ATS (Sukri et al. 2023). Pineapple by-products increase immune response in ruminants. Using pineapple by-products reduces somatic cells and increases the number of white blood cells and macrophages in dairy cows.

Table 5: Effects of supply pineapple waste (PAW) on the growth performance of cattle (Sukri et al. 2023)

Ruminant	PAW	Ration use	Application duration	ADG	
				Control	Treatment
Cross Brahman x Thaid native cattle (18 months old)	Pineapple peel		90 days	0,38 kg/head/day	0,55 kg/head/day
Cross HF x Thaid native cattle (18 month old)	Ensilage leaves and peel (50:50 in DM)		6 months	0,9 kg/head/day	1.0 kg/head/day
HF heifer (18 months)	Stems and leaves	Utilize as main forage (4, 5, 6, 7 kg DM/ngày)	210 days	Non - significant	
Beef cattle	Silage stem, leaves and peel	25% DM on TMR	6 week	12.67 kg/6 weeks	15.01 kg/6 weeks

Conclusion

Bananas and pineapples are important fruit trees in our country's export crop structure. The amount of by-products from these two crops is very large and has good nutritional value, and can be used in the diet of intensively raised ruminants. Replacing part of the ruminant diet with these by-products increases livestock efficiency and reduces production costs. Research into the processing and use of these by-products on a large scale can be applied in concentrated beef and dairy cattle farming models in our country to increase the competitiveness of the ruminant livestock industry.

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