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Nutrient Enrichment of Cassava Starch Industry By-Product Using Rumen Microorganism as Inoculums Source

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Abstract: The objective of this study was to nutrient enriched of cassava starch industry by-product using fermentation method. The experimental design was 2 x 3 factorial in Completely Randomized Design (CRD). The factor A was kind of cassava starch industry by-product (cassava pulp and cassava peel) and combine with factor B (unfermented, naturally fermented and rumen microorganism fermented). The results revealed that the interaction between cassava starch industry by-product and fermentation method were shown in dry matter and crude fiber content. Crude fiber content was decreased ($p<0.01$) with naturally fermented and rumen microorganism fermented. Crude protein content was increased ($p<0.01$) with naturally fermented and rumen microorganism fermented. However, rumen microorganism fermented was highest true protein content and lowest NPN content ($p<0.01$). Nitrogen free extract was reverse affect by crude protein content. Base on this study nutrient enrichment of cassava starch industry by product can do by fermentation method, especially rumen microorganism fermented. The rumen microorganism fermented cassava starch industry by product is potentially useful feed material for mono gastric feeding.

Key words: Cassava pulp, cassava peel, rumen microorganism, nutrient enrichment

INTRODUCTION

Cassava pulp and cassava peel are the solid waste product consequence of starch production. This pulp and peel contains a high starch, causing an environmental problem with disposal. Therefore, starch industry attempt to eliminate or make it to utilization. The use of cassava industrial by product for animal feed ingredient is one of alternatives to overcome this problem. However, cassava starch industrial by product was low protein content, but they have high starch content (Sriroth *et al*., 1999). These by-products, when properly utilized, can contribute to the development of better quality and more economical production of feed for livestock. Fermentation is an alternative method to enhance the nutrient content of feed through the biosynthesis of vitamins, essential amino acids and protein, by improving protein quality and fiber digestibility (Oboh, 2006). Many kinds fermentation method used for nutrient enriched of low protein substrate, such as a mixed culture of *Saccharomyces cerevisae* and *Lactobacillus spp*. solid media fermentation techniques (Oboh, 2006), fermented with rumen fluid (Adeyemi *et al*., 2007; Ezeronye, 2004), fermented with *Bacillus amyloliquefaciens* (Wizna *et al*., 2008) and by *Aspergillus niger* in solid state fermentation. However, fermented with rumen fluid should be considered because of the advantage of rumen microbes. They have many kinds of microbes in rumen fluid such as fungi bacteria and protozoa. Mixed microbes can be utilized low quality substrate and non protein nitrogen for synthesized microbial protein, by improving protein quality. This study therefore sought to investigate the effect of unfermented, naturally fermented and rumen microorganism fermented of cassava starch industry by product on the nutrient quality of fermented product.

MATERIALS AND METHODS

Sample preparation and experimental design: Cassava pulp and cassava peel were collected from cassava starch industry. The pulps and peels were dried in a hot, dry air force oven at 65°C for 72 h. All samples were ground to pass through a 1 mm screen and stored in airtight container. The experimental design was 2 x 3 factorial in Completely Randomized Design (CRD) with five replicated. The factor A was kind of cassava starch industry by-product (cassava pulp and cassava peel) and combine with factor B (unfermented, naturally fermented and rumen microorganism fermented). The treatment combinations were following; T1 = unfermented cassava pulp, T2 = naturally fermented cassava pulp, T3 = rumen microorganism fermented cassava pulp, T4 = unfermented cassava peel, T5 = naturally fermented cassava peel and T6 = rumen microorganism fermented cassava peel.

Fermentation methods: Cassava starch industry by-product was grounded using hammer mill and the both flour were subjected to fermentation. Mixed rumen microbe (500 ml rumen fluid) was added into 1000 mL of nutrient solution and buffer [20 g urea, 47.94 g

$NaHCO_3$ and 4.47 g NH_4HCO_3] and inoculated into 400 g of flour and then allowed to ferment at 39°C for 4 day in anaerobic chamber, while the second group was fermented naturally without any inoculums. The product obtained was subsequently dry at 65°C in hot air oven. Dried product and unfermented sample was analyzed in laboratory chemically for proximate constituents (AOAC, 1990) and non protein nitrogen (Licita *et al*., 1996).

Statistical analysis: All data obtained from the trials were subjected to the analysis of variance procedure of statistical analysis system (SAS, 1996) according to a 2 x 3 factorial in completely randomized design. Means were separated by Duncan New's Multiple Range Test. Significance was shown at $p<0.05$ unless otherwise noted.

RESULTS AND DISCUSSION

The chemical compositions of product are shown in Table 1 and 2. The substrate and fermentation method had interaction on dry matter content of the product. Dry matter content of naturally fermented cassava pulp, rumen microorganism fermented cassava pulp and naturally fermented cassava peel was decline. This finding was similar to those reported by other researchers (Adeyemi and Familade, 2003). Dry matter content was reduce with fermentation, because of associated increased moisture content with advanced fermentation duration.

Ash contents were ranged from 1.64% for naturally fermented cassava pulp to 13.60% for rumen microorganism fermented cassava peel. The ash content of cassava peel was higher than cassava pulp ($p<0.01$). Generally, cassava peel had high ash content because of contamination with sand and soil in the process of production. There was significant increased ($p<0.01$) in the ash content of rumen microorganism fermented product, when compared to unfermented and naturally fermented (Table 2). The increase could attribute to the added some nutrient and buffer solution into substrate with advanced fermentation duration. Crude fiber content in the product was interaction between two factors (substrate and fermentation method). There was significant decrease ($p<0.01$) in crude fiber content of rumen microorganism fermented cassava pulp and cassava peel (Table 1). This decrease was highest in rumen microorganism fermented cassava peel, from the others treatment could be attributed to the possible rumen microbe secretion of some extra cellular enzymes such as cellulase in to the cassava peel and degraded the fiber. These results are in agreement with previous studies (Adeyemi *et al*., 2007; Noomhorm *et al*., 1992), who reported that crude fiber content was significant reduced with fermentation. There was no significant different in protein content of cassava pulp and cassava peel (Table 2). However, crude protein content of product increased with fermentation method, especially in rumen microorganism fermented product (18.41%). This finding was similar to those reported by other researchers (Adeyemi *et al*., 2007; Ezeronye, 2004). The increase in protein content of fermented product could be attributed to proliferation of microbial bodies and trap of nitrogen sources for microbial protein synthesis. However, true protein in rumen microorganism fermented product was highest, when compared the unfermented and naturally fermented. This result implies that the rumen microbes have high potential to synthesizing microbial protein. Additionally, non protein nitrogen residue was lowest in rumen microorganism fermented product. This result implies that the product suitable for mono gastric feed.

There was significant decrease ($p<0.01$) in the nitrogen free extract content of fermented product (Table 2). The incidence of this experiment might have been associated with the ability of microbial complex to hydrolyze starch into glucose and ultimately the glucose will be used by the same organisms as carbon source to synthesize microbial protein. The results are in agreement with previous studies in *Saccharomyces cerevisae* and *Lactobacillus spp*. solid media fermentation techniques (Oboh, 2006) and by rumen filtrate fermentation (Adeyemi *et al*., 2007). There was no considerable difference ($p>0.05$) in the ether extract. These observations do not agree with those of Adeyemi *et al*. (2007) who reported that ether extract was increased with rumen filtrate fermentation.

Table 1: Chemical composition of nutrient enriched cassava starch industry by product (by treatment)

Chemical composition	T1	T2	T3	T4	T5	T6	SEM
Dry matter %	96.04^{ab}	87.61^{d}	90.55^{dc}	95.44^{ab}	92.41^{bc}	96.86^{a}	0.80
Ash %	1.69^{d}	1.64^{d}	8.85^{b}	7.24^{c}	6.45^{c}	13.60^{a}	0.78
Crude fiber %	10.69^{a}	10.61^{a}	4.94^{b}	11.31^{a}	6.82^{b}	2.27^{c}	0.68
Crude protein %	2.52^{c}	16.77^{b}	17.58^{ab}	2.49^{c}	15.89^{b}	19.24^{a}	1.33
Non-protein Nitrogen (NPN) %	0.08^{c}	5.95^{a}	3.60^{b}	0.01^{c}	6.24^{a}	2.40^{b}	0.47
True protein %	2.43^{c}	10.82^{ab}	14.58^{a}	2.39^{c}	9.65^{b}	16.76^{a}	1.06
Ether extract %	0.51	0.64	0.74	0.66	0.76	0.72	0.03
Nitrogen Free Extract (NFE) %	80.62^{a}	57.95^{c}	58.45^{c}	73.73^{b}	62.48^{c}	61.02^{c}	1.71

Where: T1 = unfermented cassava pulp, T2 = naturally fermented cassava pulp, T3 = rumen microorganism fermented cassava pulp, T4 = unfermented cassava peel, T5 = naturally fermented cassava peel and T6 = rumen microorganism fermented cassava peel. Means in the same row with different superscripts differ ($p<0.01$)

Table 2: Chemical composition of nutrient enriched cassava starch industry by product (by substrate and fermentation methods)

	Substrate		Fermentation methods		
Chemical composition	Cassava pulp	Cassava peel	Unfermented	Naturally fermented	Rumen microorganism fermented
Dry matter %	91.40^{b}	94.90^{a}	95.70^{a}	90.0^{b}	93.70^{a}
Ash %	4.06^{b}	9.10^{a}	4.50^{b}	4.10^{b}	11.22^{a}
Crude fiber %	8.70^{a}	6.80^{b}	11.00^{a}	8.70^{b}	3.60^{c}
Crude protein %	12.29	12.54	2.50^{c}	16.33^{b}	18.41^{a}
Non-protein Nitrogen (NPN) %	3.01	2.94	0.09^{c}	6.09^{a}	2.74^{b}
True protein %	9.27	9.60	2.40^{c}	10.23^{b}	15.60^{a}
Ether extract %	0.62	0.71	0.58	0.70	0.72
Nitrogen Free Extract (NFE) %	65.67	65.74	77.17^{a}	60.21^{b}	59.74^{b}

		Comparison		
Chemical composition	SEM	S	F	S*F
Dry matter %	0.80	**	**	*
Ash %	0.78	**	**	NS
Crude fiber %	0.67	**	**	**
Crude protein %	1.33	NS	**	NS
Non-protein Nitrogen (NPN) %	0.46	NS	**	NS
True protein %	1.06	NS	**	NS
Ether extract %	0.02	NS	NS	NS
Nitrogen Free Extract (NFE) %	1.70	NS	**	NS

Where: S = substrate, F = fermentation method and S*F = interaction between S and F, Means in the same row with different superscripts differ ($p<0.01$)

Conclusion: The present study, therefore, reveals that rumen microbes greatly influences the chemical composition of cassava starch industry by product positively, by increasing protein content of product and at the same time reducing the level of crude fiber. Therefore, the product is suitable for mono gastric feed.

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