PROTEIN SUPPLEMENT FLOUR OBTAINED BY FOAM MAT DRYING OF ENRICHED PINEAPPLE PEEL

Jônatas G. M. Santos[1], Daniel P. da Silva[1], Isabelly P. da Silva[1], Veruschka V. Franca[1], Odelsia L. S. de Alsina[2] & Luciano F. Monteiro[1]*

[1] *Universidade Federal de Sergipe, Centro de Ciências Exatas e Tecnologias, Departamento de Engenharia de Produção.*
[2] *Universidade Federal de Campina Grande, Unidade Acadêmica de Engenharia Química. (retired professor)*
** Corresponding author's email address: lucianofm@academico.ufs.br*

ABSTRACT

Agroindustry wastes could be a disposal environmental problem or a valuable raw material for food industry. Obtention of flour or cake protein supplement by drying enriched pineapple peel was investigated. The fruit wastes, enriched by Saccharomyces cerevisiae cell growth were dried in stove using conventional or foam mat techniques. Enrichment was conducted by semisolid cell growth at ambience condition (28±2 ºC) during 48 hours with 15% of *Saccharomyces cerevisiae* inoculated into the substrate. Part of the sample was mixed with 25% of eggs white beating during 5 minutes in a home mixer at high speed. The obtained foam was stable and expanded 87% relative to the unfoamed sample. Samples of fresh and enriched pineapple wastes, both foamed and unfoamed, were dried in stove with natural convective circulation at 75±5 ºC. The final moisture content of dried pineapple skin was 33.3% and 16.6 % for fresh, foamed and unfoamed, respectively after 650 min, whereas the enriched waste shown 38.9% and 14.3% final moisture content after 460min for foamed and unfoamed samples, respectively. The comparison between foamed and unfoamed wastes results confirmed that the foam mat drying is largely favorable to improve the drying rate.

Keywords: Waste utilization. Foam Mat drying. Protein enrichment.

1 INTRODUCTION

The agroindustry has great economic, social and food importance, however, there are several problems relative to the adequate disposal of waste, discarding tons of biomass into the environment[1]. The Brazil was the fourth largest pineapple producer in the world in 2022, producing more than two million units[2]. Pineapple (*Ananas comosus*) has great economic importance in fresh consumption, pulp, juices and several other by-products. The fruit residues, including peel, core, stem, crown, and leaves, account for 60 % (w/w) of the total pineapple weight[3], whereas peel represents around 29–40 % of the total fruit weight[4]. Therefore, the search for feasibility to use pineapple waste is of great value for better rentability of the fruit production, which can promote the emergence of a new consumer market, cause economic benefits and positively impact the environment[5]. Pineapple wastes can be used as substrate for the protein enrichment process. The pineapple peel has sugars that can serve as a source for the fungus *Saccharomyces cerevisiae* cell growth, which develops a bioproduct with a higher protein content[6]. Several studies demonstrate the potential of using fruit waste as a substrate for protein enrichment using yeast, obtaining a product with a protein enrichment index (IEP) of 5.07 [7]. Semisolid fermentation was also used for protein enrichment of guava [8] and jackfruit residues[9]. Protein supplements for feed can overcome certain deficiencies in ruminant nutrition[7]. The animal feed supplement is a homogeneous mixture in the form of bran with moisture less than 13%, contains 18% to 20% crude protein and around 70% total digestible nutrients[10]. After protein enrichment, due to cell growth in a semisolid state, the residues have around 75% moisture [11; 5; 12]. Therefore, drying enriched residues for animal feed is an essential step in the production process.

Foam mat drying is a method in which it is used a foaming agent to increase the process performance. The formation of bubbles produces a larger area in contact with the air flow improving the heat and mass transfer[13]. Among other foaming agents, eggs white is a widely used component. The egg is rich in proteins, such as albumin, globulin and ovomucoids, which are essential for the formation and stability of blisters[14]. The foam mat technique was used for various types of material. Among them, instant yam flour (*Dioscorea rotundata*)[15], banana (*Musa spp.)* flour [16], pumpkin (*Cucurbita spp*.) puree flour[17], with similar behavior to the pineapple residues, used in this work.

2 MATERIAL & METHODS

Pineapple from local market was peeled and then, the skin was crushed in a domestic processor. A part of the pineapple crushed peel was inoculated with 5% *Saccharomyces cerevisiae* yeast, being enriched through cell growth in an isolated environment for a period of 48h at an ambient temperature of 28±2°C. The moisture content of samples containing fresh pineapple skin and after protein enrichment was determined by drying in an oven at 105°C for 24h to determine dry mass[18].

Part of the residues fresh end enriched were foamed with egg white. Four types of samples were obtained: fresh (*in natura*) residue with and without foaming agent and protein-enriched residue with and without foaming agent. The four samples were dried in an oven with natural convection circulation at 75ºC±5°C. More details about experimental conditions are shown in Table 1 and in the flowchart in Figure 1.

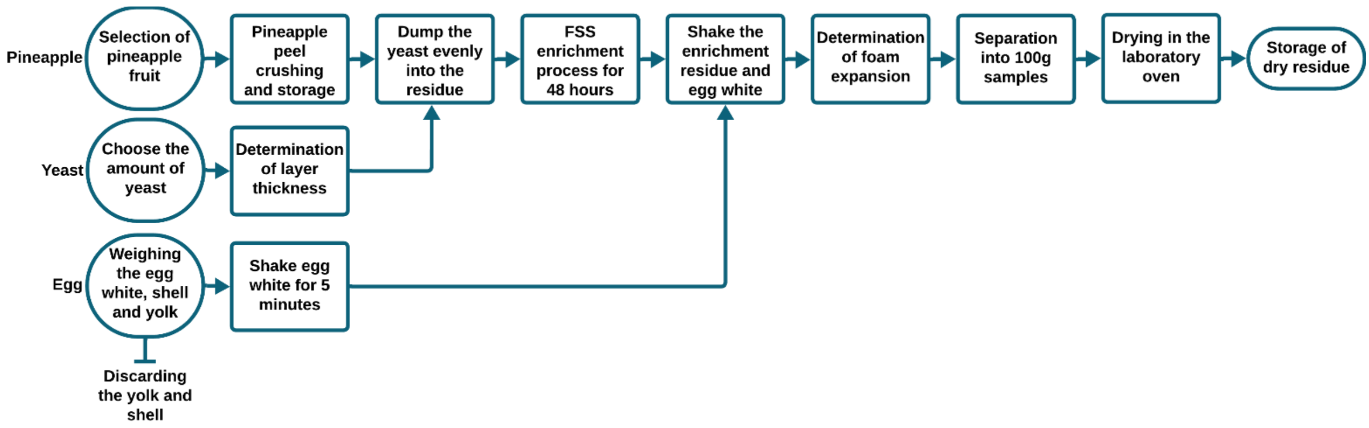

Figure 1 Flowchart for the process of obtention of dried enriched product from pineapple peel by foam mat technique.

Monitoring of drying was carried out through periodic weighing and the percentage of moisture in the wet base (Ubu) calculated by Equation 1.

$$Ubu\ (\%) = \frac{m_{sample} - m_{dried}}{m_{sample}} \times 100 \quad (1)$$

3 RESULTS & DISCUSSION

Table 1 shows the experimental conditions as well as some results of characterization and drying. As shown in the Table1 foam with a reasonably good expansion was obtained and the final moisture content of the foamed material was less than a half of the value obtained in the case of residues without eggs white for both samples, fresh and enriched.

Table 1 Drying pineapple peel. Experimental conditions and results.

Pineapple Peel samples	U_{BU} initial (%)	ρ g/cm³	Foaming agent concentration (%)	Foam expansion (%)	Drying time (min)	Drying rate in constant rate period (g/min)	U_{BU} final (%)
Fresh, unfoamed	89	0,75	-	-	650	0,18	33,30
Fresh, foamed	88	0,53	15	41,50	650	0,21	16,63
Enriched, unfoamed	89	0,86	-	-	470	0,20	38,89
Enriched, foamed	88	0,46	25	86,96	460	0,28	14,29

The drying curves for the four samples are shown in Figures 2a and 2b for the fresh and enriched residues respectively. In the figures, a constant drying rate period is observed during approximately 150 min followed by a decreasing rate period.

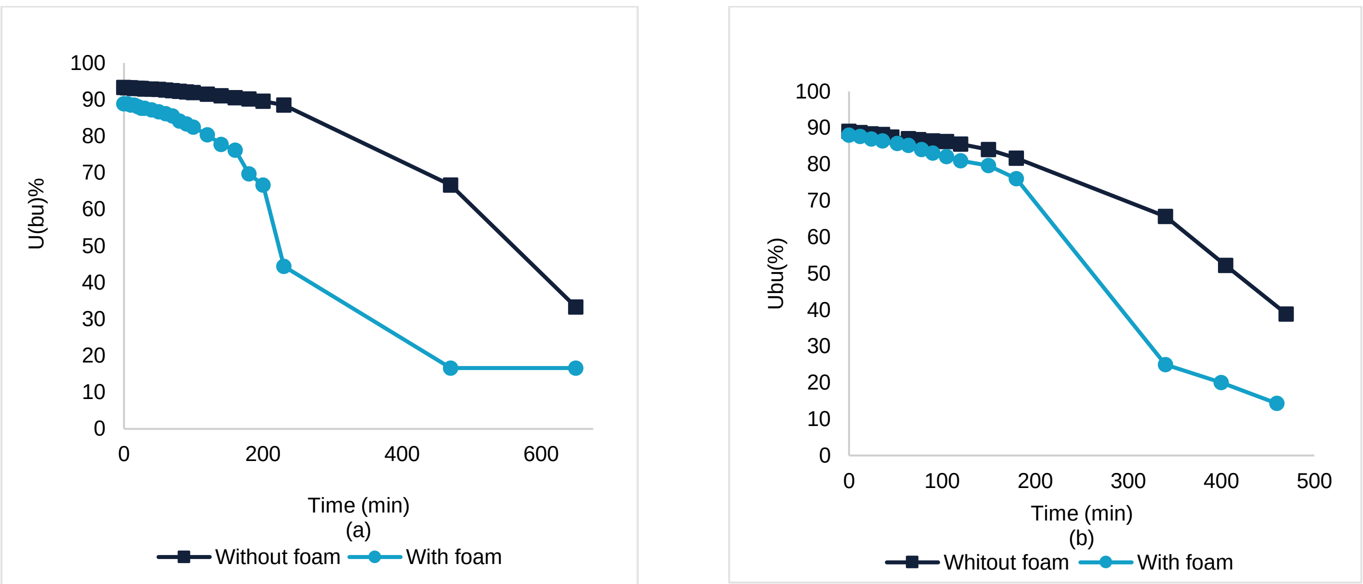

Figure 2 Drying curves of pineapple skin (a) fresh (b) enriched.

It is evident from the figures that in both cases, the presence of foaming agent increases the drying rate. The performance of the process is improved leading to lower energy consumption and shorter operating times.

As seen in Table 1, the drying rate in the constant rate period increased with the addition of the foaming agent in both processes: drying pineapple residues without and with protein enrichment, resulting in a lower final moisture content product.

4 CONCLUSION

The proposed process makes it possible to obtain a protein supplement from pineapple waste. Using the foam layer drying technique, the product is obtained with lower moisture levels and can be storaged in the form of cake, powder or flour for animal feed. Further studies will be carried out for the physical-chemical analysis of samples, optimization of operations and inspection of economic viability.

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