12 Cassava Processing in Africa

Olusola B. Oyewole

Cassava is an important food crop in the tropics and many countries in Africa. The crop contributes significantly to the diets of over 800 million people, with per capita consumption averaging 102 kilograms per year. In some areas of Africa it constitutes over 50 percent of the daily diets of the people.

Traditionally, cassava is processed before consumption. Processing is necessary for several reasons. First, it serves as a means of removing or reducing the potentially toxic cyanogenic glucosides present in fresh cassava. Second, it serves as a means of preservation. Third, processing yields products that have different characteristics, which creates variety in cassava diets.

The objective of this paper is to detail the strategy and program being followed in our laboratory to utilize the knowledge of biotechnology to improve the processing of cassava in Africa.

TRADITIONAL PROCESSING

Processing of cassava for food involves combinations of fermentation, drying, and cooking. Fermentation is an important method common in most processings. While there are many fermentation techniques for cassava, they can be broadly categorized into solid-state fermentation and submerged fermentation. Solid-state fermentation, typified by gari production, uses grated or sliced cassava pieces that are allowed to ferment while exposed to the natural atmosphere or pressed in a bag. Submerged fermentation involves the soaking of whole peeled, cut and peeled, or unpeeled cassava roots in water for various periods, as typified by the production of fufu and lafun in Nigeria. Traditionally, cassava is fermented for 4 to 6 days in order to effect sufficient detoxification of the roots.

(The support of the International Foundation for Science, Stockholm, Sweden, is gratefully acknowledged.)

Some processors, out of economic pressure, ferment cassava for less than 2 days. Some cases of food poisioning have been attributed to this practice. Application of biotechnology to traditional cassava processing has prospects for producing safe and well-detoxified products.

RESEARCH APPROACH

Our approach on cassava processing research is divided into three areas:

1. Investigating the science of the traditional submerged fermentation of cassava to fufu and lafun production;

2. Optimization of the processing through process controls; and

3. Improvement of traditional processing through application or biotechnological techniques.

The microorganisms involved in the submerged fermentation process have been isolated and found to include Bacillus subtilis, Klebsiella sp., Candida tropicalis, C. krusei, and a wide spectrum of lactic acid bacteria, major among which are Lactobacillus plantarum and Leuconostoc mesenteroides. A microbial succession trend was found with the starch degrading Bacillus subtilis, giving way to the lactic acid bacteria and yeasts that dominate the latter part of the fermentation. The pH and titratable acidity of the fermenting cassava roots increased from 6.3+0.2, 0.08+0.03 percent to 4.0+0.3, 0.36+0.05 percent, respectively, after the 96-hour fermentation period. Organic acids produced during fermentation include lactic, acetic, propanoic, and butanoic acids, among others, and these are believed to contribute to the characteristic flavor of fermented cassava products. Fermentation causes release of some bound minerals, including calcium and magnesium. The most important contribution of fermentation is the release from the plant tissues of the enzyme linamarase, which is involved in the breakdown of the linamarin and lotaustralin (cyanogenic glucosides) of cassava, which releases hydrogen cyanide and thus detoxifies the product.

PROCESS OPTIMIZATION

Processing conditions for optimizing the fermentation process have been investigated in our laboratory. We found that the temperature range of 30° to 35°C, with a soaking period of 48 to 60 hours, is best for submerged processing. The size to which the roots are cut, peeling or nonpeeling of roots before processing, changing or nonchanging of fermentation water at intervals during processing, and the age of roots all affect the characteristics of the final product. In addition, the protein contents of products can be improved by cofermentation with legumes such as soybeans and cowpea.

BIOTECHNOLOGICAL INVESTIGATIONS

The overall goal of our biotechnological investigations is to develop an appropriate starter culture for cassava processing that will effectively produce linamarase enzymes for detoxifying cassava, break down starch to the simple sugars needed for acid production, improve the protein content of the products, reduce processing time, and yield products with stable desired qualities. The following summarizes our current findings:

· The microorganisms involved in fermentation have been characterized.

· Characterized isolates were used as single and multiple starter cultures for cassava fermentation. This has made it possible to understand the roles of each of the microorganisms implicated in the natural fermentation process. Bacillus subtilis and Klebsiella spp. contribute significantly to the rotting of cassava roots. In addition, B. subtilis produces amylase enzymes that are necessary for the breakdown of starch to sugars, which are needed for the growth of other fermenting microorganisms, including the tactics. Yeasts play a major role in odor development and, where high yeast biomass is encouraged, protein-enriched products are not. Lactic acid bacteria convert cassava sugars to lactic and other acids that contribute to the flavor in addition to having preservative effects.

· Appropriate starters have been developed that can produce amylase and linamarase enzymes necessary for starch breakdown and cyanogenic glucoside hydrolysis; two major biochemical processes needed in cassava processing. For this, the lactic acid bacteria were investigated since they were the predominant microbial group present at the beginning of fermentation and which persist and survive the acidic conditions that prevail in cassava fermentation. To date, we have found strains of Lactobacillus plantarum that are capable of producing amylase and linamarin. The linamarase produced has been purified, and it exhibits optimal activity at pH 5 to 8 and temperature of 30° to 40°C. Prospects for cassava processing using a selected single culture with properties for starch hydrolysis, cyanide detoxification, and acid production have thus evolved.

· To initiate genetic manipulation of cassava lactic acid bacteria, the plasmid profiles of the lactobacilli isolated from cassava were studied. The presence of plasmids among cassava lactobacilli has been confirmed. Further research is needed to investigate the correlation between possession of plasmids and linamarase production in order to establish prospects for genetic manipulation.

FUTURE RESEARCH

Beyond the selection of appropriate starter cultures for cassava fermentation, it will be necessary to improve the starter culture. Genetic manipulation of the starter culture offers the best hope for improved cassava processing, with higher economic returns and improved stable qualities.

Cassava processing could also be enhanced by using biotechnological principles to modify structural and processing characteristics of cassava cultivars to meet specific product requirements.

The linamarase elaborated by cassava plant tissues and fermenting microorganisms has been found to be unstable under high acidic conditions characteristic of the latter part of natural fermentation. Techniques for increasing the stability of linamarase enzyme to acidic conditions could be investigated.

The usefulness of cassava fermenting microorganisms could be further investigated for the production of other economically viable products such as acidulants and antimicrobial agents.

A biotechnological approach could be investigated for the treatment of odorous fermented cassava water and cassava root peels.