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SCANNING ELECTRON MICROSCOPY STUDIES OF THE CELLULAR CHANGES IN RAW, FERMENTED AND DRIED COCOA BEANS

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Abstract

Cocoa beans are submitted to a curing process of fermentation and drying to develop flavor precursors. The beans must have reached maturity; otherwise, no amount of processing can produce the desired flavor. Early work with cacao cell cultures showed that only when the cells were "matured" could a chocolate or cocoa flavor result from further processing. Fermentation is therefore required because unfermented beans may develop little chocolate flavor when roasted. Likewise, the outcome of excessive fermentation may also result in unwanted flavor. Thus, the first major post-harvesting phase to have an impact on flavor development is that of fermentation. During this phase of curing, the mucilaginous pulp surrounding the beans undergoes an ethanol, acetic and lactic fermentation. The acid and heat generated kill the beans with a resulting change in cell membranes. This facilitates enzyme and substrate movement with notable swelling of the bean. Changes induced in the beans during the process affect the texture and flavor quality. This paper relates texture of the bean to cellular and subcellular transformations observed by scanning electron microscopy.

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Introduction

Chocolate, which is manufactured from the seeds of Theobroma cacao owes its popularity and world-wide appeal to its unique and characteristic flavor. Prior to being processed into chocolate, the seeds from the ripe fruits, immediately following harvesting, are subjected to a fermentation and drying process during which the flavor precursors are developed. Only after undergoing such a process do the seeds (commonly referred to as beans) possess those attributes necessary and desirable for the manufacture of chocolate. The term, 'fermentation', is misleading when applied to the curing of cocoa because, although typical alcohol, lactic and acetic fermentations occur in the pulp that surrounds the seed, the reactions that are responsible for the formation of the flavor precursors are reactions between the seed enzymes and their substrates (Lopez, 1986). In the intact bean these substrates are separated and compartmentalized by biological barriers which break down during the fermentation treatment. The liberation and intermixing of enzymes and substrates lead to spontaneous reactions which are governed by the physicochemical conditions of fermentation. They are influenced by the external microflora of fermentation and the method used. Thus the fermentation process and the biochemical transformations that it provokes inside the bean are of major importance in the development of chocolate flavor. The majority of investigations aimed at elucidating the nature of chocolate flavor have been directed at the chemistry of fermentation and the manufacturing process in contrast to the few reports on the micro-structure of the seed (Roelofsen, 1958; Duncan and Todd, 1972; Vaughan 1970) and that provoked by fermentation (Biehl, 1973; Hoskin et al., 1980). The present study attempts to address this subject utilizing scanning electron microscopy (SEM) techniques.

Materials and Methods

Ripe fruit of Theobroma cacao of the Forestero variety were obtained from the Cacao Research Center of CEPLAC (Comissao Executivo do Plano da Lavoura Cacaueiro). Immediately after removal from the fruits, samples of the seeds