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On the nature of the Ca binding to the hull of *nixtamalized* corn grains

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Abstract

Corn hull is composed of cellulose, hemicelluloses and a minor fraction of lignin. Hemicelluloses are acidic polysaccharides which could explain the relatively large ability of the corn hull to retain Ca during the cooking of corn in a saturated solution of $Ca(OH)_2$. In order to shed light in this sense the Ca binding to the hull of alkaline cooked corn grains was studied using EDS, pH titration, IR and ^{13}C CP/MAS NMR techniques. For short cooking times, prior to hull degradation, Ca is retained in the corn grain according to the following order: hull > germ > endosperm. The acidic groups of hemicelluloses (mainly uronic acids) are the responsible for Ca retention in the corn hull. The amount of Ca retained by the hull approximately is 4 mg/g. On the alkaline cooking the hull is progressively degraded and loses its ability to retain Ca because the hemicelluloses fraction passes to the cooking liquor.

Keywords: Tortilla; Corn hull; *Nixtamalization*; Hemicelluloses; Infrared; ^{13}C CP/MAS NMR

1. Introduction

In Mexico and Guatemala corn is mainly consumed as Tortillas. Tortillas are prepared from mass or flours obtained through an alkaline cooking and steeping of corn grains in a saturated solution of $Ca(OH)_2$, process known as *nixtamalization*, which is used in this region from prehispanic times. The traditional process was industrialized several decades ago but preserving the alkaline cooking of the corn grains (Pflugfelder, Rooney, & Waniska, 1988). This treatment is oriented to remove the corn hull, to make corn proteins available and to incorporate Ca to the cooked grains, increasing the nutritional levels of the mass or flours elaborated from *nixtamalized* corn (Trejo-González, Feria-Morales, & Wild-Altamirano, 1983). Approximately 50% of Ca intake in Mexico, mainly in rural regions, is provided by Tortillas and other products elaborated from *nixtamalized* corn (Serna-Saldivar, Gomez, & Roney, 1990). It is accepted that of the total Ca employed in *nixtamalization* only a small fraction is retained in the grain during the cooking and resting periods (Trejo-González et al., 1983). In the germ Ca is found as salts of fatty acids, due to a partial saponofication of its fats during the alkaline cooking, while in endosperm it is forming inclusion compounds of these salts within the amylose helical structure (Reguera, Yee-Madeira, Fernández, & Sánchez-Sinencio, 2000). Little attention has been given to the possible retention of Ca by the corn hull (pericarp) and on its state in this part of the grain, although, as will be discussed latter, the presence there of species capable of bind Ca. The aim of the present contribution is to carry out a systematic study on the Ca binding to the corn hull. In this sense the hull of corn grains before and after their alkaline cooking in a saturated solution of $Ca(OH)_2$ was study using X-ray energy-dispersed spectroscopy (EDS), pH titration, infrared (IR), ^{13}C cross polarization magic angle spinning NMR (^{13}C CP/MAS NMR) and atomic absorption spectrophometry (AAS). This study was also oriented to evaluate the hull ability to bind Ca on the alkaline cooking. This process leads to a progressive

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