

INFLUENCE OF THE SOLUBLE SOLIDS ON THE ZETA POTENTIAL OF A CLOUDY APPLE JUICE

E. I. BENITEZ and J. E. LOZANO

PLAPIQUI (UNS-CONICET), CC 717, (8000) Bahía Blanca, Argentina.

jlozano@plapiqui.edu.ar

Abstract-- The effect of soluble solids on the Zeta-potential (ξ) of a cloudy apple juice was investigated. Apple juice was enzymatically treated with pectinolytic enzymes and diafiltered with a polysulphone UF membrane (100 kDa) to eliminate soluble solids. Most soluble solids were removed after 4 equivalent sample volumes (ESV) of washing water. During a second period, from 5 to 23 ESV, diafiltration rate was significantly reduced. ξ (mV) moderately increased its absolute value with diafiltration during the first diafiltration period, changing at a rate of -1.1 mV/°Brix up to 0.3 °Brix). Results also indicated that after the only restitution of sugars ξ remained practically constant. When malic acid was restituted to a diafiltered juice, remarkable changes in Zeta potential occurred. As particles in this type of colloids are strongly negative, pH modification had a significant influence.

Keywords— Cloudy apple juice, diafiltration, soluble solids, Zeta-potential.

I. INTRODUCTION

Apple juice can be produced cloud stable with the application of suitable processes. The juice contains a large amount of fine particles and pectin, so that throughout the storage time only little cloud will be deposited. Turbidity shows a lesser intention to sediment due to the smaller particle size and dissolved pectins, which increase the viscosity of the juice. However, the composition of cloud particles has an influence on the stability of the juice.

Cloudy apple juice is a colloidal suspension where the continuous medium is a solution of pectin, sugars (fructose, glucose and sucrose) and malic acid. The dispersed matter is mainly formed by cellular tissue comminuted during fruit processing. Colloidal particles consist of proteins, lipids, neutral polysaccharides, pectin and other substances like minerals (Pecoroni and Gierschner, 1993; Dietrich *et al.*, 1996). The literature discusses different models for building a stable cloud particle. The cloud particles contain a core, consisting of protein, which is positively charged. These speculations are supported by those of Yamasaki *et al.* (1964) and Endo (1965); in which cloud particles containing a positively charged protein core, are surrounded by a

carbohydrate shell consisting among others of negatively charged pectin. This positively charged core is able to build a complex with negatively charged pectin. Moreover the formation of a protein-polyphenol complex was also discussed (Pecoroni and Gierschner, 1993). Cloud particles are modeled to consist of negatively charged partly demethoxylated pectin wrapped around a core of carbohydrates and positively charged protein (Beveridge, 1997). Depectinization may partially degrades pectin and expose protein beneath. Then aggregation between polycations and polyanions occurs, making possible the colloid flocculation. Both clarification of fruit juices with gelatin and cloudy juice stabilization with alginates confirm this model (Belitz and Grosch, 1997).

A protein's state of ionization is determined not only by the nature of its side chains but also by the pH of the solution environment. In acidic conditions proteins tend to acquire a net positive charge. In basic conditions, proteins tend to have a net negative charge. Between these extremes, at a precise value of the pH called the isoelectric point, the value of which is unique for each species of protein, the most thermodynamically stable form of the protein has equal numbers of positive and negative charges and does not migrate in an electric field (Magdassi and Kamyshny, 1996).

Colloidal particles accumulate charge at their surface that can be expressed as a surface potential. Surface potential is an important factor for determining the magnitude of charged-based colloidal interactions of a particle, most crucially electrostatic repulsion of other like charged particles. The surface charge on a particle perturbs the ionic distribution in the medium surrounding it. First a layer of tightly bound counterions (i.e. of opposing charge) accumulates at the particle surface, known as Stern layer, and beyond this a region of decaying excess concentration, the diffuse layer, extends a considerable distance into the surrounding aqueous media (McClements, 1999).

The repulsion is not a simple case of physical rebounding between particles. Repulsion occurs in part as a result of the interaction of the diffuse electrical double layer of charge produced between the particles. As the ionic strength of the juice increases, the thickness of the double layer decreases. When negatively charged particles approaches each other (both with double