Acid Dairy Drink Induced by Pectin

- on Stabilization Mechanism and Effective Use of Pectin -

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Acid dairy drinks (ADD) are a worldwide product existing in many variations: fruit milk drinks, yogurt drinks, soy milk, butter milk, whey drinks and kefir etc.

These drinks are marketed with different shelf lives depending on processing:

- Short shelf life (maximum 3 weeks, cold storage)
- Long shelf life (2 to 9 months, pasteurized, sterilized or retorted)

Acidic protein based drinks tend to a separation or destabilization process in the absence of stabilizing system during the shelf life of the ADD. A phase separation results in sedimentation of large particles at the bottom of the package and / or the formation of a serum layer at the top (whey off).

These beverages are usually composed of an acid dairy phase (fermented base) or a natural base (milk, soymilk etc.) with an acidic medium (fruit phase: pulp, fruit concentrate etc.) which can be flavored. Sugar and stabilizers are also added. It has been proved since the late 1950's that adding high methoxy pectin (HM pectin) to acid milk drinks is the best way to prevent the formation of a sediment and/ or the whey off.

In this presentation, we explain about stabilization mechanism of ADD induced by pectin.

Applications and market trend of ADD in Asia and Europe are explained.

Ⅰ. Pectin

Pectin is a natural colloid extracted from citrus peels and apple pomace. Pectin is a complex, high molecular weight polysaccharide mainly composed of partially methyl-esterified of polygalacturonic acid. High methoxyl ester pectin (often called HM-pectin or High Methoxyl pectin) is pectin with a degree of esterification above 50%. In the acid dairy drink applications, HM pectin of DE close to 70% are generally used.

Ⅱ. Processing the pectin

1. Dispersion & solubilization

Most commonly, pectin is introduced into the dairy base via an aqueous phase.

In order to have a good solubilization of the pectin, a part of sugar can be introduced and a pasteurization treatment is conducted in plate heat-exchanger or a double -jacket vat.

A second possibility is to solubilize the pectin in syrup. Another way consists to a direct dispersion in the dairy base. These two methods request an easy dispersion/ solubilization ability.

Ⅲ. Technique for production ADD

Following two main techniques for production ADD are considered.

A) Direct acidification of a neutral base (milk, soy milk, butter milk...) with an acidic medium (fruit juice, organic acid solution...) or the use of an acidic base (acid whey...).

B) Use of fermented base: mechanical force needs to be applied to the food preparation to ensure a homogeneous and stable matrix.

The methods of used are as the following:

A) Preparation of pectin solution by a mix of pectin and sugar in hot water under stirring and pasteurized in a double jacket vat at 90℃ and cool down to 20℃.

B) Preparation of ADD: addition of the pectin solution in the fruit juice, mixing the dairy base / flavor with the mixture pectin: juice, homogenization.

Then, the product can be conditioned in aseptic level and stored in chilled conditions or can be heat-treated on a heat exchanger and filling into packaging materials before storage in fridge.

Sometimes, the product especially on glass bottles is submitted to a restored sterilization.

Ⅳ. Stabilization mechanism of ADD induced by pectin

ADD are beverages consisted of acidified milk (below PH5) which are diluted and homogenized.

In these conditions the casein micelles agglomerates producing a floc which sediments quickly.

To prevent this sedimentation polymers are used in the ADD, mainly pectin, then CMC and soy fiber etc.

The polymer is attach to the casein by electrostatic interaction between the negative charges of the polymer and positive charges of the casein producing a highly hydrated layer next to the surface of the casein, which prevents the casein agglomeration by "steric" stabilization.

Followings are theoretical aspect how ADD can be stabilized by pectin at various manufacturing conditions

1. Theoretical aspect

Pectin has different effects on the casein particles depending on the concentration.

1) At medium concentration, pectins act as a dispersing agent. The attachment of the pectin onto the casein particles is due to the electrostatic attraction between ionized carboxyl groups of the pectin and the amino groups of the protein (Fig. 1).

The high esterified galacturonic acid part of the pectin induces a highly hydrated layer next to the casein particle surface, preventing particle aggregation. The repulsion is not due to electrostatic

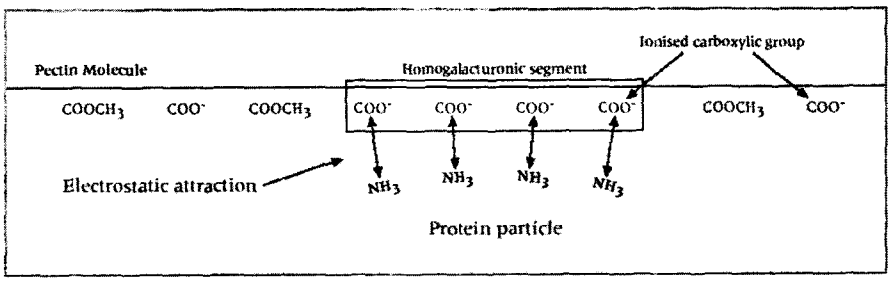
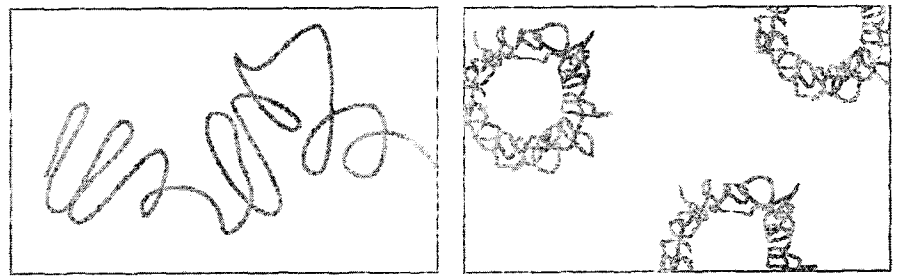
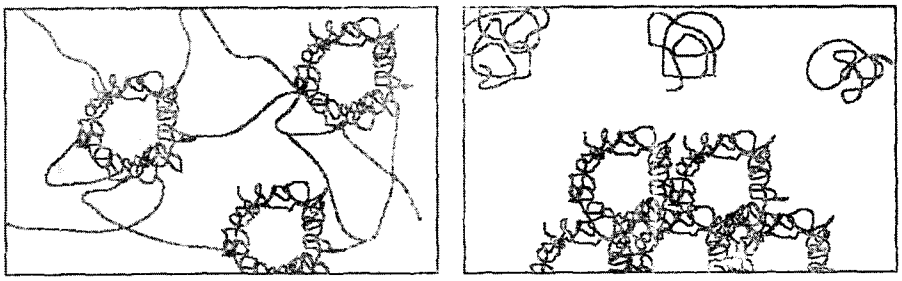


Fig. 1. Schematic model of pectin electrostatic interaction at the surface of a protein particle at pH<pr.



Scheme A- Precipitation by bridging a low pectin concentration

Scheme B- Aggregation prevented by medium pectin concentration



Scheme C- Stabilized particles by network formation at an optimum pectin concentration

Scheme D- Flocculation by depletion phenomenon at high pectin concentration

Fig. 2. Interaction between peetin and casein particles as a function of pectin concentration in an acid dairy drink.

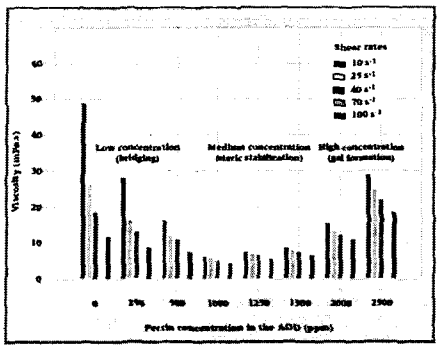


Fig. 3. Evolution of the Acid Dairy Drink viscosity as a function of pectin concentratio - ADD 8% MSNF based on a homogenized yogurt.

phenomenon. In fact, if the covered particles are too close, the hydrated layers overlap, which increases the local polymer concentration, producing repulsion between particles by osmotic effect(Fig.2-scheme B).

Experimentally, at this pectin concentration, we can observe low viscosity, Newtonian behavior (Fig. 3) and small particle size (Fig. 4).

2) If the quantity of HM pectin is not sufficient, the pectin layer onto the casein is not complete.
There is a possibility of electrostatic fixation/bounding of pectin on more than one casein surface. In these conditions, precipitation occurs by bridging (Fig. 2-scheme A).
Experimentally, at this pectin concentration, we can observe a high viscosity, pseudoplastic behavior (Fig. 3) and high particle size (Fig. 4).

3) At optimum concentration (depending on the grade of pectin, the MSNF and the processing of ADD), pectin/pectin and pectin/casein interactions occurred, producing a weak mixed gel, which prevents proteins sedimentation.
After shearing the drink by shaking, we have a very quick recovery of gel properties.

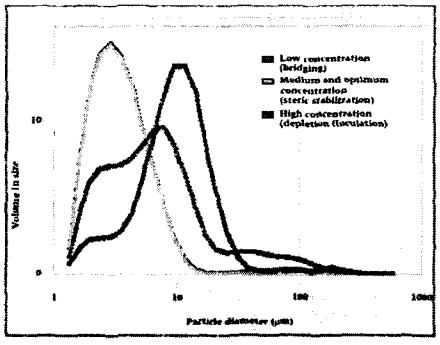


Fig. 4. Evolution of the particle size distribution as a function of pectin concentratio - ADD 8% MSNF based on a homogenized yogurt.

This property allows an easy handling of the beverage without risk of destabilization (Fig.2-scheme C). Experimentally, at this pectin concentration, we can observe an increasing viscosity, a Pseudoplastic behavior (Fig. 3), small particle sizes (Fig. 4) and the presence of a gel.

4) At a pectin quantity higher than the dose required in the application, the beverage can present a flocculated visual appearance, which can be explained by depletion phenomena.

Due to osmotic pressure induced by excess of polymer the water between the covered particles are expulsed leading to an aggregation. Sedimentation is prevented by the pectin network (Fig.2 -scheme D).

Experimentally, at this pectin concentration, we can observe a high viscosity, pseudoplastic behavior (Fig. 3) and increasing particle size (Fig. 4) and the presence of a gel.

Ⅴ. ADD preparation

1. Mixing

A mixing stage is needed in the process in order to intimately mix the dairy phase with the stabilizer system. The effectiveness of the mixing is dependent on the equipment (level of shear) and mixing conditions.

2. Homogenization

Homogenization of the final blend of dairy components and stabilizer is essential and results in:

1) Particle size reduction as is an emulsion technology, homogenization reduces the particles size and makes them easier to suspend.
2) Molecular level mixing: Homogenization triggers the turbulent flow at a molecular level necessary to stick the HM pectin molecules to the surface of the protein particles.

3. Thermal treatment

Casein denatured by fermentation or direct acidification is very sensitive to thermal chock.

It induces dehydration and gives a "sandy" texture. A gradual heat treatment is required to reduce the temperature difference between the source of heat and the beverage. The highly hydrated layer of pectin next to the surface of the casein micelles acts as a "colloidal protector".

4. Protein stabilizer

Casein in milk at its natural PH of around 6.6 is in the form of stable sub-micron particles, often called micelles. When the PH of milk is lowered below 5,the micelles of casein start to agglomerate and form a weak gel (curd). If the gel is diluted or broken by stirring for an acid dairy drink, the aggregated casein separates into large flocs which sediment rapidly.

5. Unipectine AYD Series

We have been producing AYD series which acts as a stabilizing agent. The production of a well-stabilized acid milk drink is similar to that of an emulsion. It is necessary to create small particles of protein which are coated with the dispersing agent - HM pectin - which prevents these particles from agglomerating.

In order to act as a stabilizing agent, HM pectin must first adsorb to the casein surface and then cause repulsion between them.

Ⅵ. Unipectine AYD Series Performance

We have developed a high-speed centrifugation test on ADD in order to standardize the Unipectine AYD series. This test is based on the measurement of the volume fraction of the drink. We evaluate the compressibility of the pectin/casein sediment as a function of the pectin content in the ADD in fixed conditions (Fig. 5). The higher sediment (Fig. 6), the more efficient the pectin is in the ADD.

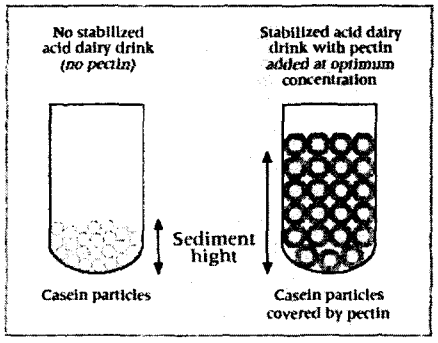


Fig. 5. Principle of standardization of Unipectine ™ AYD specially designed for Acid dairy Drinks – High speed sedimentation test

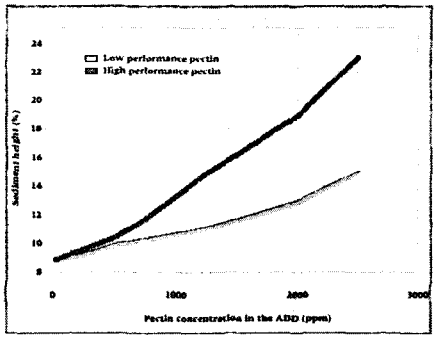
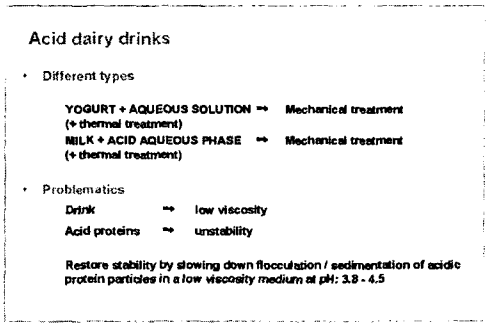
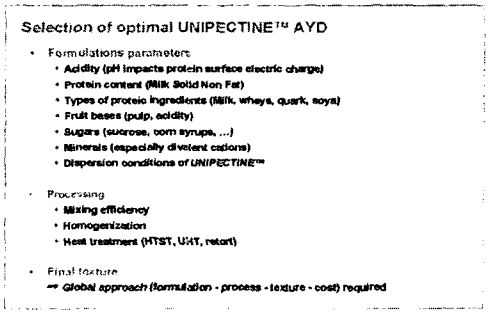
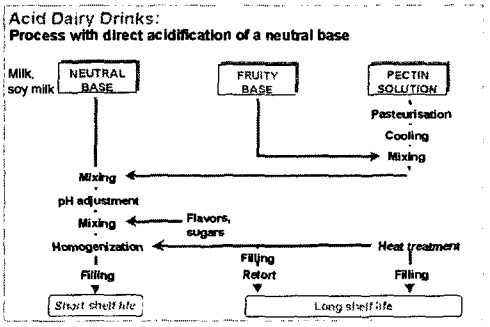
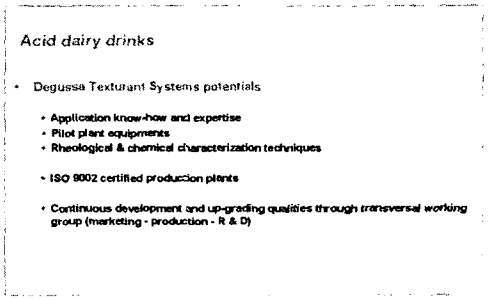


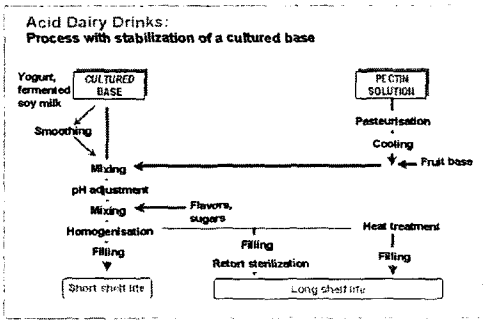
Fig. 6. Evolution of the sediment as a function of pectin concentration in our high speed centrifugation test.











Ⅶ. Application

The ADD market is in the process of segmentation and covers an extensive scope of recipes (MSNF: 0.5-10%, PH:3.8~4.6, calcium or fiber enrichment) and of process conditions (short/long shelf-life). Protein stabilization in acidic environment and fine-tuning of final texture require a careful selection of pectins (Unipectine AYD Series).

A target ADD is produced by selecting a comprehensive citrus pectin range fitting with most types of raw materials (whether dairy or vegetable) and of MSNF/PH combination.

Additionally apple pectin is in AYD series so that it provides a unique mouth-feel to ADD.

Several representative recipes are explained.