
# New colloids as fat substitutes

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# Agenda

- Proposal: to present some foods made with partial replacement of fat, replacing it with hydrocolloid.

# Fat Foods

- Fat is an essential component of the human diet, and fatty components are therefore much appreciated during eating. Traditionally, there have been many different ways to incorporate fat in meals.

- Fat foods are products with considerable fat content in the formulation.

# Fat Foods

- The final characteristics of processed fat products depend on the physical and chemical properties of oils and fats that participate in its formulation.
- The correct structure of products is essential to obtain products with desirable properties.

# Polysaccharides

- Natural polysaccharides have been widely investigated in recent years in relation to their physicochemical characteristics and applications. Some of its properties are biodegradability, abundance in nature and versatility of applications in engineering, biotechnology, medicine and food because they are generally nontoxic.

# Hydrocolloids

- Polysaccharide hydrocolloids are high molecular weight macromolecules that are easily dissolved and dispersed in water, and under appropriate conditions they can modulate rheological properties used as food.

- A *hydrocolloid* is defined as a colloid system wherein the colloid particles are hydrophilic polymers dispersed in water.

# Microestructure and rheology

- The rheological characterization of the developed products demonstrates the features of their behavior determining the relationship between the structure and interactions of the various ingredients in foods and the final rheological properties of the gel.

# Chichá gum
# Application example 1: chocolate filling

- *Sterculia* genus trees are known for its acidic polysaccharides with high solution viscosity and gelation characteristics. The *Sterculia striata* is a species native to most Brazilian regions and has been compared with other polysaccharides such as guar gum which has a multitude of applications in the food industry.

Amaral, A.A.

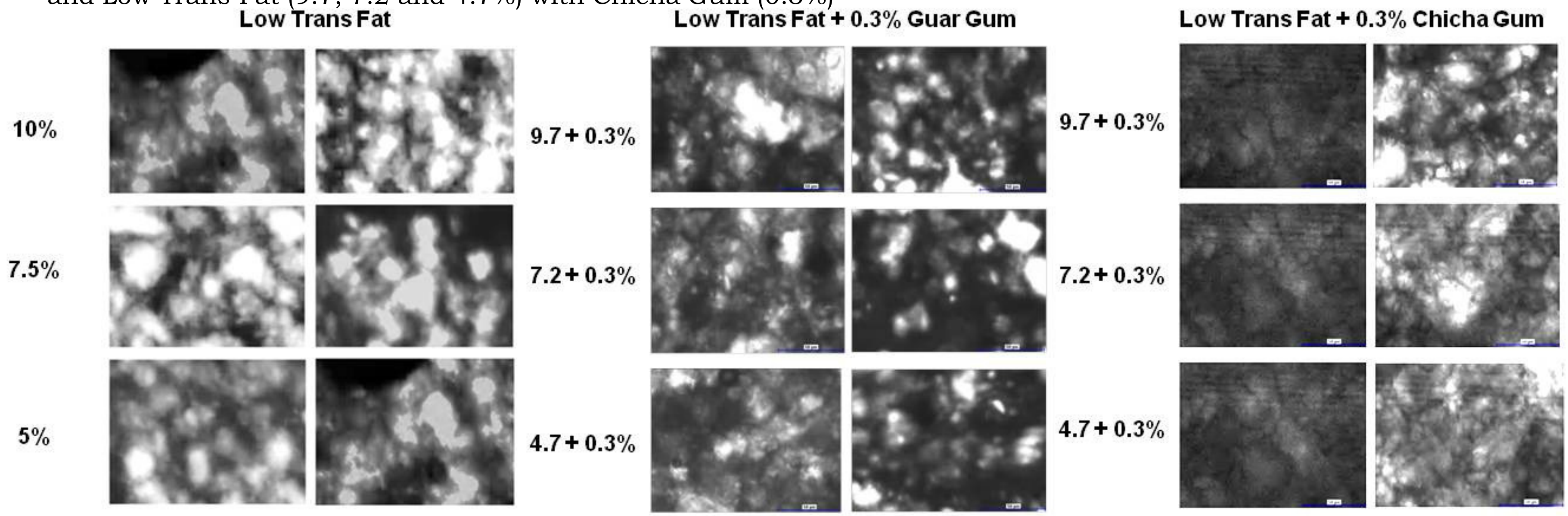
# Chichá gum
# Application example 1: chocolate filling

Three conventional fat based formulations were prepared with low trans fat, at concentrations of 10%, 7.5% and 5%, and six others with the addition of 0.3% (w/v) of guar gum and chichá gum individually. The formulations were prepared respecting the steps of weighing, heating, emulsifying and packaging, with 17% sugar fondant (Fleischmann), 13% orange pulp concentrate (Lanjal), 5% of alcohol 40 °GL (Emfal) and fat base containing 54.7%; 57.2% and 59.7% white chocolate type cover (Nestlé), 0.3% soya lecithin (Braswey), 5%, 7,5% and 10% vegetable fat low trans (BUNGE LT-Pro Mult 44).

Amaral, A.A.

# Chichá gum
# Application example 1: chocolate filling

Polarized light microscopy, obtained by Rheoscope module (increased = 20x), in the initial stage (left column) and in the final phase of the rheological analysis (right column) for the samples for samples containing Low Trans Fat (10; 7.5 and 5%) and Low Trans Fat (9.7; 7.2 and 4.7%) with Guar Gum (0.3%) and Low Trans Fat (9.7; 7.2 and 4.7%) with Chicha Gum (0.3%)




The images obtained at the start and at the end of the analyzes confirm the structure recovery; it can also be observed the smaller size of the fat globules and a better crystal definition with less agglomerate formation.

Amaral, A.A.

# Chichá gum
# Application example 1: chocolate filling

- The formulations made with guar and chichá gums showed similar behavior and pronounced thixotropy by a decrease in apparent viscosity with time, followed by recovery of the structure of the system. Thus, it is concluded that the rheological properties of the fillings are significantly altered by the addition of the studied gums, even at low concentrations.

Amaral, A.A.

# Cashew gum
# Application example 2: chocolate

- The cashew gum is a heteropolysaccharide of exudate species *Anacardium occidentale* L., and has characteristics similar to those of arabic gum, representing a potential substituent to various gums used in food industry.

# Cashew gum
# Application example 2: chocolate

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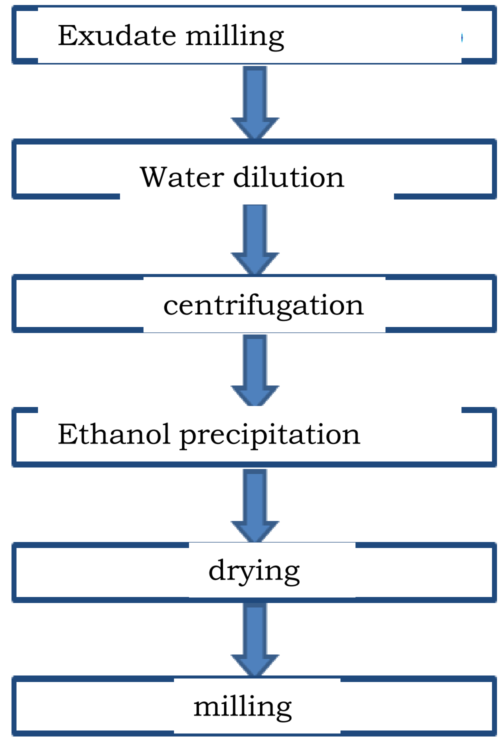
Cashew gum exsudate (a); purified cashew gum (b).



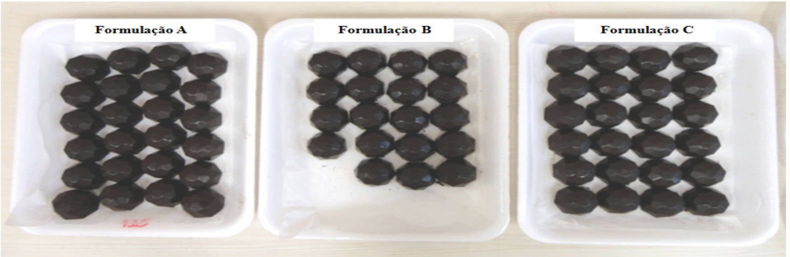
# Cashew gum
# Application example 2: chocolate

Composition of cashew gum by Paula e Rodrigues (1995)[1] e Botelho (1999 )[2]
**Font:** Freitas, 2010.

| Monosaccharides | Composition (%)[1] | Composition (%)[2] |
|---|---|---|
| Galactose | 73 | 69.78 |
| Arabinose | 5 | 11.84 |
| Glucose | 11 | 9.78 |
| Rhamnose | 4 | 2.28 |
| Mannose | 1 | 0.97 |
| Glucuronic acid | 6.3 | 0.52 |
| Xylose | - | 1.29 |

Santos, G.

# Cashew gum
# Application example 2: chocolate




Chocolate Composition (%)
Lecithin: 0,5%; flavor: 0,3%.

| Composition | Formulation A | Formulation B | Formulation C |
|---|---|---|---|
| Cocoa liquor | 45.4 | 45.4 | 45.4 |
| Sugar | 42.5 | 42.5 | 42.5 |
| Cocoa butter | 11.3 | 10.3 | 8.3 |
| Cashew gum | 0 | 1 | 3 |

Santos, G.

# Cashew gum
# Application example 2: chocolate

**Chemical analysis of the different chocolate formulations in relation to the average moisture content, ash, lipids, proteins, fiber, total carbohydrate (g / 100g) and calorific value (kcal / 100g)**
**Analyses carried out on a wet basis. * Obtained by difference; Values followed by the same letter on the same line do not differ at 5% significance level.**

| | Form. A | Form. B | Form. C | Com. 1 | Com. 2 |
|---|---|---|---|---|---|
| Humidity | 2.0 ± 0.1[a] | 2.2 ± 0.1[a] | 2.5 ± 0.1[b] | 0.9 | 1.0 |
| Ash | 2.4 ± 0.2[a] | 2.5 ± 0.0[a] | 2.5 ± 0.0[a] | 1.1 | 2.7 |
| Lipids | 30.0±1.5[a] | 28.2 ± 1.8[a] | 26 ± 1.7[a] | 33.6 | 28.4 |
| Proteins | 6.2 ± 0.4[a] | 6.5 ± 0.6[a] | 6.1 ± 0.7[a] | 6.8 | 6.0 |
| Carbohydrate | 56.8 | 60.6 | 61.2 | 33.6 | 28.4 |
| Caloric value | 413.0 | 413.7 | 410.1 | 520 | 504 |

addition of cashew gum did not alter the thermal properties of chocolates

Santos, G.

# Chicken feet gelatin
# Application example 3: chocolate spread

- The majority of the gelatins produced by the industries are extracted from cattle hides, beef bones, and pork skin.

- However, by sociocultural issues and frequent occurrence of diseases, there is a growing interest in developing alternative sources of raw materials with good physical properties.

- Considering that Brazil is one of the largest of poultry meat in the world as a result generating large amount of byproducts rich in collagen and also that the texture is one of the most important commercial criteria used to evaluate the quality of a gelatin.

# Chicken feet gelatin
# Application example 3: chocolate spread

**Table 1** – Composition of formulations control and with partial replacement of fat by gelatin solution

| **Ingredients (%)** | **Control** | **50 % fat** |
|---|---|---|
| Dark chocolate | 38.46 | 38.46 |
| Vegetable fat | 28.67 | 14.44 |
| Glucose syrup | 14.43 | 14.43 |
| Refined sugar | 9.52 | 9.52 |
| Water | 5.71 | 18.93 |
| Invert sugar | 1.93 | 1.93 |
| Skimmed milk powder | 0.91 | 0.91 |
| Lecithin | 0.4 | 0.4 |
| Gelatin powder from chicken feet | - | 1.0 |
| **Total** | **100** | **100** |


Appearance and behavior of the control formulations (a) and with addition of gelatin and fat reduction (b) at temperature of 30 °C.

Almeida, P.F

# Chicken feet gelatin
# Application example 3: chocolate spread

| Formulations | Density (g/cm³) | Specific volume (mL/g) | Consistency (N) | Color parameters | | |
|---|---|---|---|---|---|---|
| | | | | L* | a* | b* |
| **Control** | $0.93^{a}$±0.00 | $1.07^{a}$±0.00 | $45.6^{a}$±1.65 | $30.42^{a}$±0.04 | $13.99^{a}$±0.39 | $23.72^{a}$±0.02 |
| **50 % gelatin solution** | $1.08^{b}$±0.01 | $0.93^{b}$±0.01 | $9.65^{b}$±0.08 | $20.18^{b}$±0.07 | $15.87^{b}$±0.03 | $24.73^{b}$±0.17 |

Note: Different letters in the same column represent significant difference
($P < 0.05$). Mean ± SD (in triplicate samples).

The formulation with the addition of gelatin was darker than the control showing L* value of 20.71 e 30.42 respectively. All color parameters L*, a* and b* were significantly different between the two formulations.

The formulation with higher fat content showed high consistency value (45.6 N) considered too hard, while the sample with replacement of gelatin can be classified as hard, but satisfactorily spreadable (9.65 N).

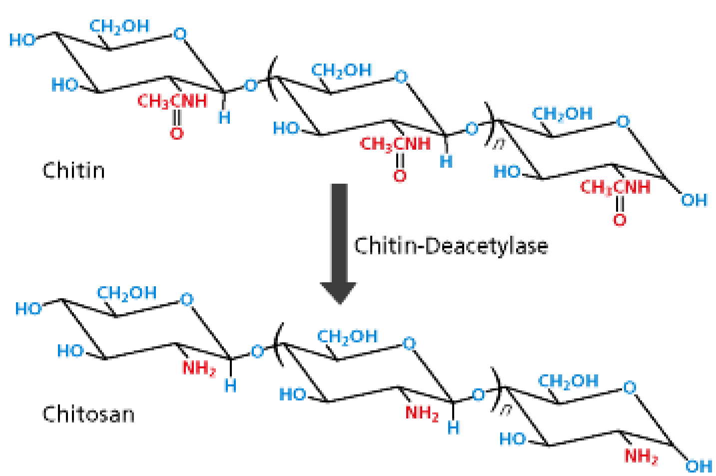
Thus, initially, it was possible the development of chocolate spread with the addition of gelatin in partial replacement of fat.

# Modified chicosan hydrogel
# Application example 4: ice cream

- The objective was to investigate the potential of a chemically modified polysaccharide when applied as structuring agent in colloidal systems.

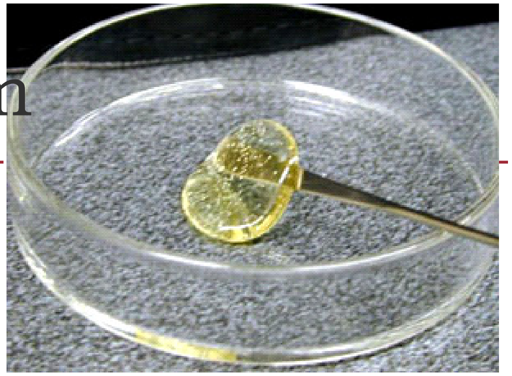
# Modified chicosan hydrogel
# Application example 4: ice cream

- Chitosan is a natural polysaccharide composed of β(1-4)-D-glucosamina units originated from the total or partial deacetilation of chitin in alkaline solutions. It is soluble in acid medium (pH<5.5) due to the presence of free amino groups along the polymer chain. The presence of these amino groups allows the synthesis of different chitosan derivatives .




Silva Jr, E.

# Modified chicosan hydrogel
# Application example 4: ice cream



*N* - succinil chitosan gel

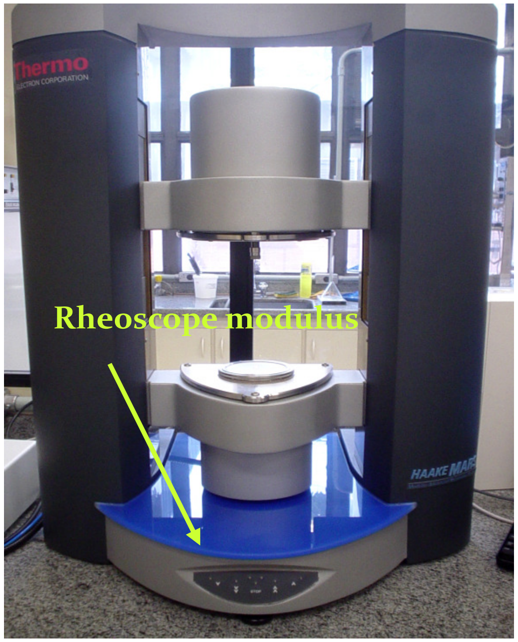
Chitosan 50% deacetyled → (Stirring) → Acetic acid → (Distilled water under stirring) → Ethanol

→ (Stirring) → Succinic anydrid → (Stirring (3h) Static (10h)) → Sodium hidroxide pH 6,0 – 6,5 → (Filtration) → Re-suspension distilled water pH adjust – 7,0

**Figure – Flowsheet of *N*-succinil production.**

# Modified chicosan hydrogel
# Application example 4: ice cream

- Emulsions were tested  at 4 °C in Oscillatory Rheometer MARS Haake. Were performed stress sweep (*0.1 – 100 Pa*), controled frequency (*1 Hz*) and frequency sweep (*0.1 – 100 Hz*), controled stress (*1 Pa*). Structural changes were monitored using a Rheoscope Modulus, coupled to Rheometer.



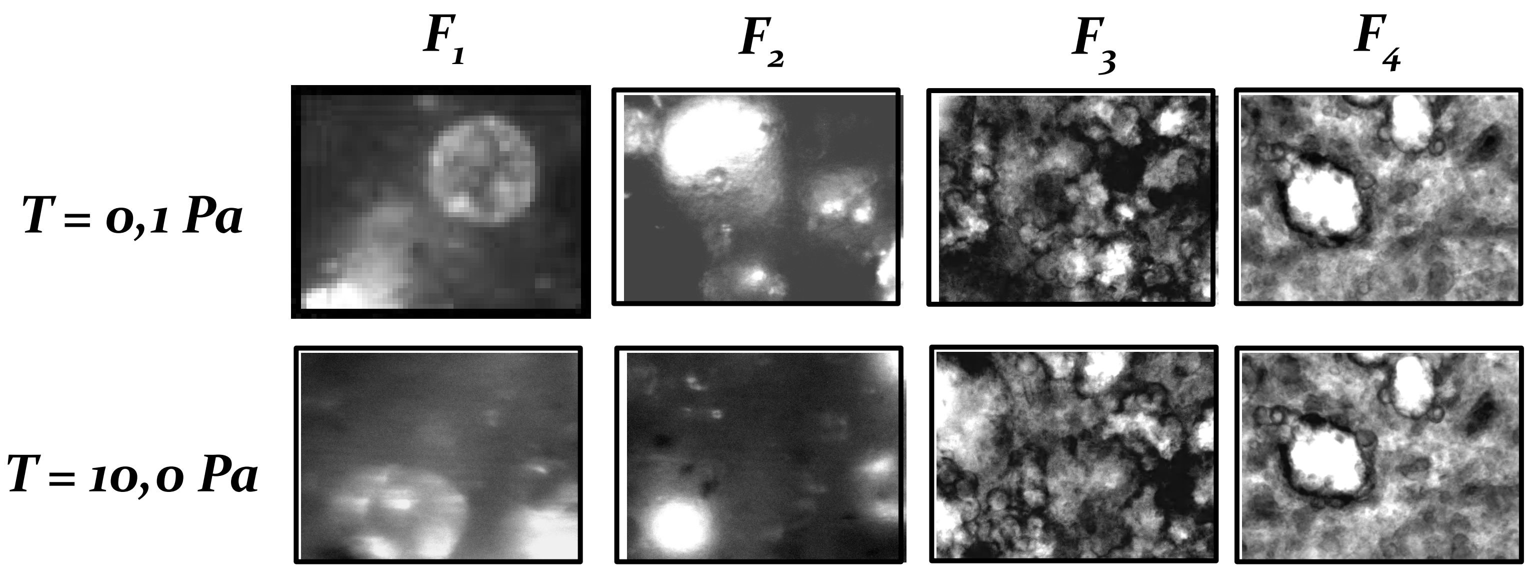

Rheometer Mars Haake

# Modified chicosan hydrogel
# Application example 4: ice cream

- Sucrose (12 %), powdered milk (14%) and chocolate (4%) and palm fat (8.1%) were used to develop four different formulations (*F*).
- Glucose and fructose syrups (4%) were added in $F_1$ and $F_2$, respectively. Both formulations were aggregated of some commercial emulsifier (0,6%).
- $F_3$ and $F_4$ were composed by same sweetener syrups and modified chitosan gel (8.0%), replaced the fat. Water was used to complete the formulations.
- The mixtures were preheated, pasteurized at 82 °C during 25 s, cooled, mixed using a mixer Fisaton 713 D at 850 rpm, and aged overnight at 4 °C.

  Ice creams were prepared, packed and stored at –18 °C.

# Modified chicosan hydrogel
# Application example 4: ice cream

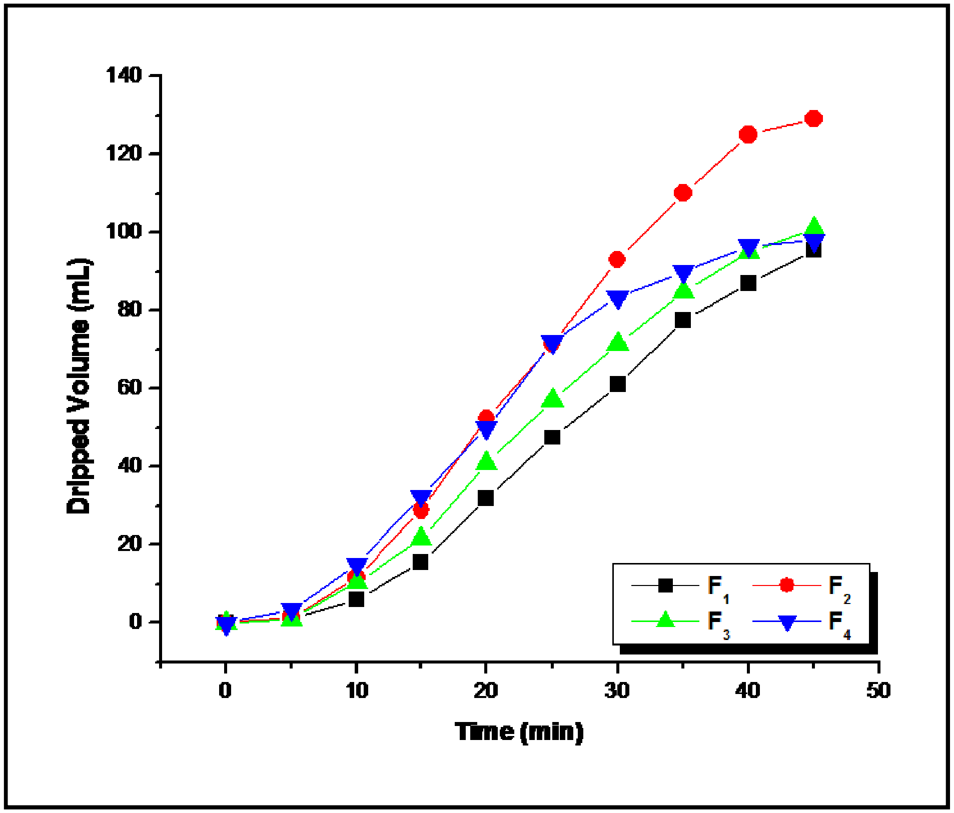



**Microstructural changes in emulsions ( *T* = 0,1 *Pa* and bottom, *T* = 10 *Pa*).**

- Fat globules size in formulations containing modified chitosan ($F_3$ and $F_4$) was reduced more than other mixes, suggesting great influence of the biopolymer on film elasticity around the fat droplets.

Silva Jr, E.

# Modified chicosan hydrogel
# Application example 4: ice cream




Melting behavior

Silva Jr, E.

# Modified chicosan hydrogel Application example 4: ice cream

- Mixes resulting by combination among chitosan and palm fat presented best characteristics. The enormous structuring power presented by this biomolecule can be very used to elaborate formulations low-fat with good textural properties. Moreover, taking in account the physiological activity, it can be employed in order to promote best nutritional quality in foods.

- This biopolymer and their derivatives, can be extensively explored, since appear do not has limitations in its potentialities.

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