



## High-intensity ultrasound-assisted chemical modification of annatto seed starch

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### Abstract

There is a new industrial trend, which aims to develop new processes in order to better exploit the agro-industrial waste, taking advantage of all the fractions originated from a single raw material. Therefore, this study presents the processing of the annatto seed aiming for the integral use of this vegetable matrix. The effects of high-intensity ultrasound (HIUS) technology on the chemical modification of the annatto seed starch through the insertion of the lipophilic component octenyl succinic anhydride (OSA) were evaluated aiming to develop of a new emulsifier for food applications. The chemical modification procedure of the starch molecules was performed employing different HIUS energy density levels (0, 1.2, 2.4 and 3.6 kJ / mL).

### Key words:

*Emerging technology, acoustic cavitation, product engineering.*

### Introduction

Annatto (*Bixa orellana* L.) is a small tree grown in tropical and subtropical regions of the world. In industry, in general, it is mainly valued for its pigmented seeds that are the source of carotenoid bixin, a natural orange and red dye<sup>1</sup>, which has multiple applications in food, cosmetics, pharmaceutical, and textiles. In addition, annatto has a  $\delta$ -tocotrienol-rich lipid fraction, about  $14.6 \pm 0.4$  g/100 g oil, and geranylgeraniol,  $25.0 \pm 0.6$  g/100 g oil<sup>2</sup>.

After the oil and colorant extraction steps using non-thermal and clean emerging technologies, the annatto biomass presents an amylaceous fraction around  $18 \pm 2$  g/100 g. In this sense, the use of the annatto seed starch as a novel emulsifier aiming food applications is a potential alternative for the full use of this vegetable matrix. Therefore, the aim of this study was to evaluate the effects of the HIUS energy density levels (0, 1.2, 2.4 and 3.6 kJ/mL) on the chemical modification of the molecular chain of annatto seed starch through the insertion of the lipophilic component octenyl succinic anhydride (OSA).

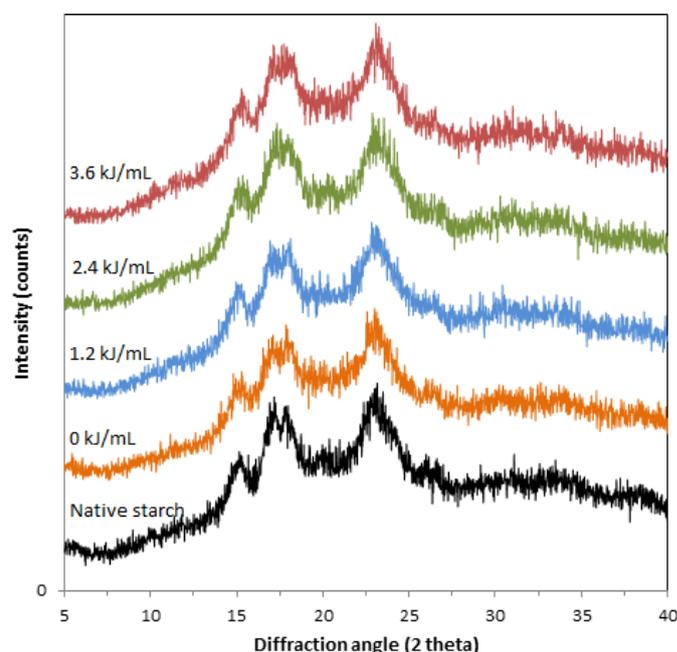
### Results and Discussion

In order to understand how the HIUS energy density acts on the chemical modification of annatto seed starch, analyzes of amylose content (AC), degree of substitution (DS), zeta potential (ZP), scanning electron microscopy (SEM), X-ray diffraction (XRD), and Fourier-transform infrared spectroscopy (FTIR) were performed. Table 1 shows the results of the analysis of DS, ZP, and AC, where can be observed the effects of HIUS energy density on annatto seed starch properties. Figure 1 presents the results of XRD analysis, which no qualitative differences were seen in the X-ray diffractograms in terms of diffraction angle and peak intensity, indicating that the main structural characteristics of starches were not altered after HIUS treatment.

**Table 1.** Effect of HIUS energy density on the chemical modification of annatto seed starch.

ED (kJ/mL)	DS (-)	ZP (mV)	AC (%)
0	$0.00 \pm 0.00$	$-38 \pm 1$	$26 \pm 1$
1.2	$0.05 \pm 0.01$	$-40 \pm 1$	$33 \pm 1$
2.4	$0.09 \pm 0.01$	$-44 \pm 1$	$32 \pm 2$
3.6	$0.14 \pm 0.03$	$-57 \pm 4$	$34 \pm 2$

ED: energy density



**Figure 1.** X-ray diffractograms of annatto seed starches.

### Conclusions

A novel emulsifier was obtained from the annatto biomass processed by non-thermal and clean emerging technologies. This work demonstrated the feasibility of the use of HIUS technology for the chemical modification of annatto seed starch. The increase of HIUS energy density promoted a higher degree of insertion of the lipophilic component into the starch molecular structure.

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