

Assessment of the conditions of the thermoplastic extrusion process in the bioactive and mechanical properties of flexible films based on starch and Brazilian pepper

Fakhouri, F. M.^{a,b,*}; Freitas de Lima, F.^{a,d}; Cardoso, C. A. L.^c; Martelli, S. M.^a; Antunes, M.^b; Innocentini Mei, L. H.^d; Yamashita, F.^e; Velasco, J. I.^b

^aFaculty of Engineering, Federal University of Grande Dourados. Dourados, MS, Brazil.

^bCentre Català del Plàstic, Universitat Politècnica de Catalunya, Barcelona, Spain.

^cResearch Center in Biodiversity, State University of Mato Grosso do Sul, MS, Brazil.

*E-mail of the corresponding author: farayde@gmail.com

Introduction and Objective

The objective of this work was to produce, through the thermoplastic extrusion process followed by blowing, manioc starch-based flexible films added with Brazilian pepper oil as an antioxidant and plasticizer agent, and verify if the bioactive compounds contained in the fresh pepper oil are present after the drying step of the thermoplastic extrusion. After analysis by gas chromatography-mass spectrometry volatiles compounds were identified in the films. Pepper oil also influenced the mechanical properties of the films. These results suggest that the temperatures used in the process, kept some of the existing compounds in the Brazilian pepper essential oil adhered to the packages.

Materials and Methods

Materials: manioc starch (MS), glycerol (GLY), brazilian pepper essential oil (BP).

The films were produced by thermoplastic extrusion following buy blowing in single screw extruder. Three formulations were produced: MS/GLY, MS?GLY/BP(2%) and MS/GLY,/BP(3%).

Chemical characterization :The analyzes were performed using a gas chromatograph equipped with a mass spectrometer detector (GCMS-QP2010 Ultra, Shimadzu, Kyoto, Japan). Total flavonoids quantification by Spectrophotometry .

Elastic modulus, tensile strength and elongation at rupture will be determined using a texturometer (Universal testing machine Galdabini SUN 2500, TA-HDi Texture Analyser (Stable Microsystem, Surrey, England), the conditions were performed by ASTM methods¹

Results and Discussion

After analysis by gas chromatography-mass spectrometry, fourteen volatile compounds were found in the essential oil of *S. terebinthifolius* (Table 1). Among these compounds, we highlight the iso-sylvestrene (34.12%), α -thujene (17.13%), myrcene (8.25%), α -phellandrene (6.68%), β -longipinene (5.90%) and sylvestrene (5.87%). After the thermoplastic extrusion process at temperatures ranging from 90 to 130°, 5 volatile compounds were identified, knowingly: α -pinene, sabinene, β -pinene, limonene and α -copaene.

Higher concentrations of pepper oil influenced the mechanical properties of the films, causing a significant increase in the elongation of the films and decrease of the tensile strength and elasticity (Fig 1).

Table 1. Monoterpene and sesquiterpene chemical characterization by gas-chromatography and total flavonoids quantification by spectrophotometry of *Schinus terebinthifolius* Raddi oil and extruded.

Compounds	RI ^a	RI ^b	Essential oil	Extruded (2%)	Extruded (3%)
α -thujene	923	924	17.13	-	-
α -pinene	939	939	1.03	17.43	18.68
α -fenchene	953	953	3.83	-	-
Sabinene	975	976	-	9.54	10.13
β -pinene	980	980	1.19	8.79	8.67
Myrcene	988	988	8.25	-	-
α -phellandrene	1002	1002	6.68	-	-
Iso-sylvestrene	1007	1007	34.12	-	-
Sylvestrene	1025	1025	5.87	-	-
Limonene	1030	1029	-	15.24	15.41
Fenchone	1083	1083	3.69	-	-
α -copaene	1377	1377	-	9.91	10.12
β -longipinene	1400	1400	5.90	-	-
Aromadendrene	1465	1465	4.63	-	-
Bicyclgermacrene	1517	1517	3.21	-	-
δ -cadinene	1519	1519	2.29	-	-
Sphatulenol	1619	1619	1.34	-	-
Total flavonoids (mg.100g QE)	-	-	-	60.77	63.49

^aRetention index calculated; ^bRetention index literature. The values of gas chromatography are expressed in % and the total flavonoids are expressed in mg.100g of quercetin equivalent.

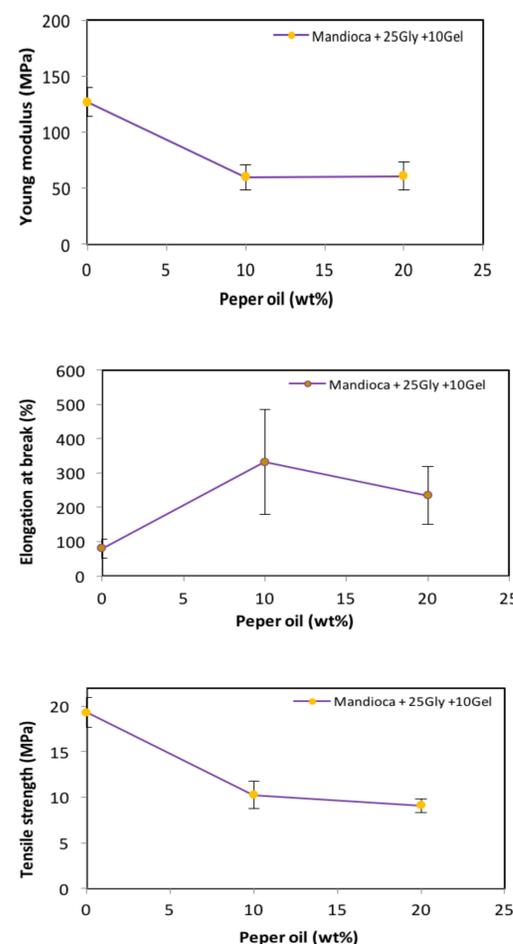


Figure 1. (a) Young modulus (MPa), (b) Elongation at break (%) and (c) Tensile Strength (MPa) of flexible films from starch and Brazilian pepper.

Conclusion

Flexible films were made with manioc starch, glycerol and brazilian pepper essential oil by thermoplastic extrusion and blowing. Five volatile compounds were identified in the film, knowingly: α -pinene, sabinene, β -pinene, limonene and α -copaene. The brazilian pepper essential oil also influenced the mechanical properties of the films. These results suggest that the temperatures used in the thermoplastic extrusion process, although high, kept some of the existing compounds in the Brazilian pepper essential oil adhered to the packages.

Acknowledgment



This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 712949



ACCIÓ
Generalitat de Catalunya
Government of Catalonia



TECNIOspring+
Tech transfer
through researchers' mobility