RECOVERY OF NUTRITIVE AND FUNCTIONAL COMPOUNDS FROM BLACK SOYBEAN AND SWEET MAIZE BY-PRODUCTS THROUGH THE SPREAD. COMPARISON WITH FRUIT JAMS AND SPREADS

Slađana M. Žilić[1a], Marijana Z. Simić[1a], Miona Belović[2], Dubravka Škrobot[2], Jelena Ž. Srdić[1b], Vesna Perić[1b]

[1]MAIZE RESEARCH INSTITUTE, [1a]Department of Food Technology and Biochemistry and [1b]Plant Breeding Department, Belgrade, Serbia

[2]INSTITUTE OF FOOD TECHNOLOGY, University of Novi Sad, Novi Sad, Serbia

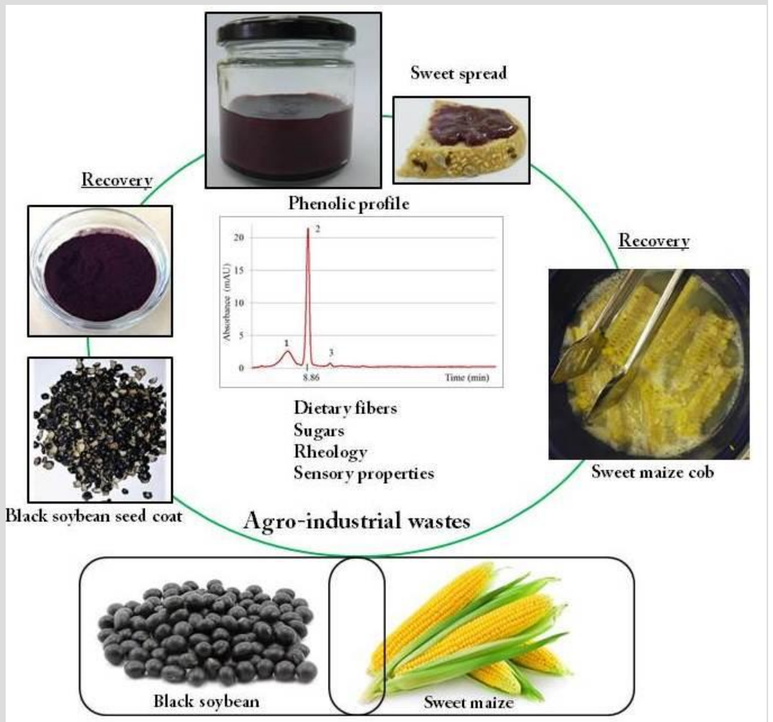
Introduction

Problem Description

From an economic and environmental point of view, the current methods of food production are not very efficient. One reason for inefficiency relates to the generation of food waste in the chain. According to research of Kummu et al. (2012), one quarter of the food produced, expressed as the food energy content, is wasted. About 39% of the total losses are generated during food manufacturing in developed countries, while approximately 42% of waste is generated in households (Mirabella et al., 2014). The greatest losses (81–97% of total food waste) in developing countries occur in the process of agricultural production (Asharadi et al., 2016). From that reason, the value-added aspects of organic waste, by-products and co-products (i.e. side-streams) have become a priority in order to respond to the sustainability, environmental, economic and regulatory challenges.

By-products, such as sweet maize cob and soybean seed coat, are considered to have little value and often are used as animal feed, or for the production of bioenergy, either through direct incineration or recently through a fermentation process. In too many cases though, these by-products are discarded as landfill.

Recovery scheme



The aim of the research

In a context of eco-efficiency and creating value-added products, the objectives of the present study were 1) to establish technology suitable for the recovery of functional compounds from by-products of black soybean and sweet maize processing industry throughout the value-added products, in this case the sweet spread, 2) to study the content of proteins, sugars, dietary fibers and phenolic compounds, as well as rheological and sensory characteristics of developed spread, and 3) to compare the properties of the spread made from the by-products with that of commercial plum and raspberry jams and spreads.

Matherials and methods

Short Description

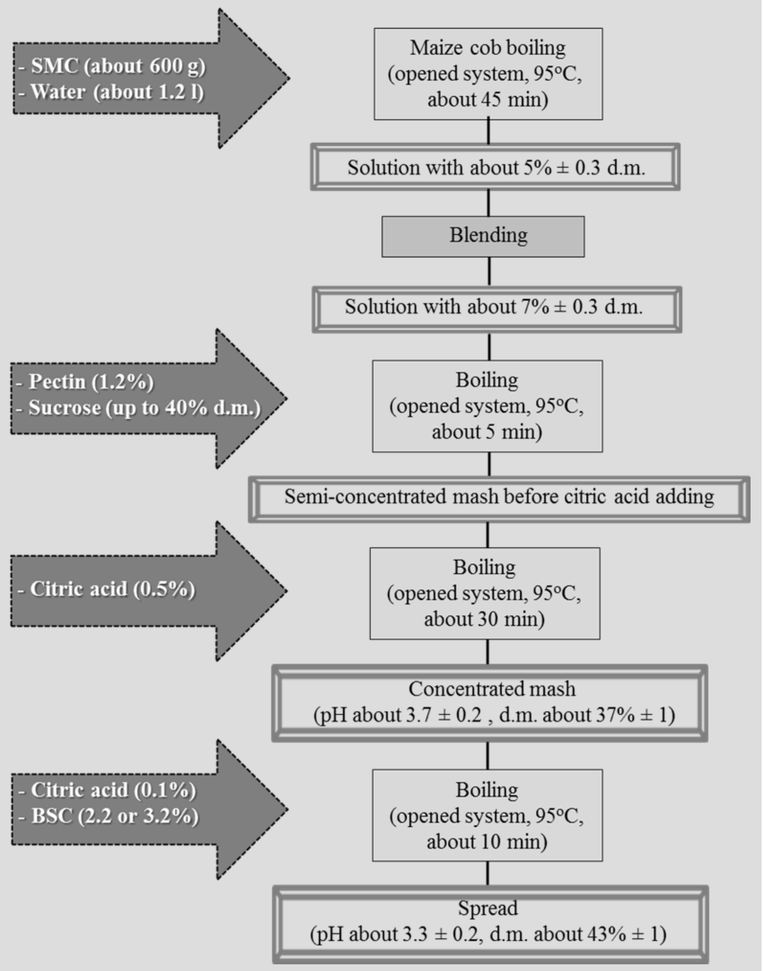
Spread from sweet maize husked cob and black soybean coat was prepared according to the procedure shown through a technological scheme .

SCM/2.2%BSC: sweet maize cob and 2.2% black soybean seed coat containing spread; SCM/3.2%BSC: sweet maize cob and 3.2% black soybean seed coat containing spread.

Due to high consumption in Serbia, plum and raspberry jams were used as control samples. Plum and raspberry jams with 56 and 69% of fruits according to producer declaration, respectively, as well as plum spread with 82% of fruit were bought in a supermarket. The products were manufactured one month before their using for analysis.
JP: plum jam; JR: raspberry jam; SP: plum spread.

Chemical analysis:
Proteins; Dietary fibers; Sugars; Total phenolic compounds; Total flavonoids; Total anthocyanins; Phenolic acids; Individual flavonoids/anthocyanins.
Rheological analysis:
Yield stress measurements; Flow curve measurements; Dynamic oscillatory measurements.
Sensory analysis:

Scheme of SMC/BSC spread production



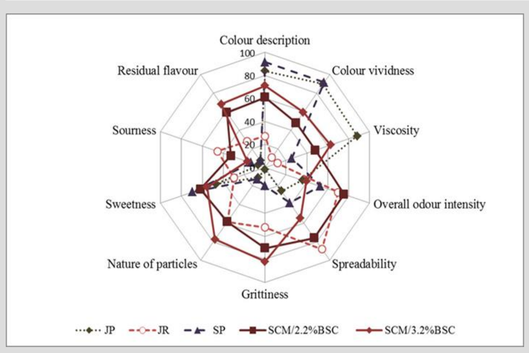
Results and Conclusion-Comparison with fruit jams and spreads

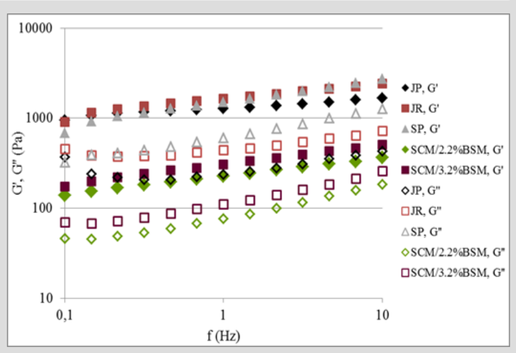
Content of soluble free phenolic compounds and antioxidant capacity of jams and spreads

	Jam		Sweet spread		
	Plum* (56% of fruit)	Raspberry* (69% of fruit)	Plum* (82% of fruit)	**SMC (2.2% of BSC)**	**SMC (3.2% of BSC)**
Total soluble free phenolic compounds					
Total phenolics (mg GAE/kg)	1696.6^{d}	5579.7^{a}	5447.1^{a}	2799.2^{c}	4026.4^{b}
Total flavonoids (mg QRE/kg)	0.97^{c}	0.97^{c}	3.49^{a}	1.12^{b}	1.52^{b}
Total anthocyanins (mg CGE/kg)	2.96^{d}	516.32^{b}	26.91^{d}	420.63^{c}	666.75^{a}
Soluble free phenolic acids					
Gallic a. (μg/g)	n.d.	1.36^{a}	n.d.	n.d.	n.d.
3,4-Dihydroxyb. a. (μg/g)	n.d.	n.d.	n.d.	20.91^{b}	38.23^{a}
Chlorogenic a. (μg/g)	42.44^{b}	n.d.	84.01^{a}	0.58^{c}	n.d.
p-Coumaric a. (μg/g)	n.d.	n.d.	n.d.	43.22^{b}	89.96^{a}
Ferulic a. (μg/g)	n.d.	2.35^{c}	n.d.	11.10^{b}	23.97^{a}
Flavonoids					
Catechin (μg/g)	n.d.	n.d.	n.d.	5.30^{a}	14.11^{a}
Rutin (μg/g)	16.57^{b}	18.35^{b}	54.09^{a}	n.d.	n.d.
Quercetin (μg/g)	n.d.	0.81^{bc}	n.d.	1.20^{b}	2.78^{a}
Anthocyanins					
De-3-Glu (μg/g)	n.d.	n.d.	n.d.	57.40^{b}	88.21^{a}
Cy-3-Sop (μg/g)	n.d.	167.77^{a}	n.d.	n.d.	n.d.
Cy-3-Glu (μg/g)	n.d.	90.20^{c}	n.d.	17.46^{b}	212.25^{a}
Cy-3-Rut (μg/g)	trace	trace	trace	n.d.	n.d.
Pt-3-Glu (μg/g)	n.d.	n.d.	n.d.	13.48^{b}	17.75^{a}
Pg-3-Glu (μg/g)	n.d.	2.66^{b}	n.d.	7.95^{a}	8.54^{a}
Antioxidant cap. (mmol TroloxEq/kg)	9.16^{c}	57.97^{a}	58.41^{a}	36.31^{b}	58.56^{a}

Content of proteins, sugars and dietary fibers in jams and spreads

	Jam		Sweet spread		
	Plum* (56% of fruit)	Raspberry* (69% of fruit)	Plum* (82% of fruit)	**SMC (2.2% of BSC)**	**SMC (3.2% of BSC)**
Ash (%)	0.24±0.01^{d}	0.6 ±0.03^{c}	0.80±0.03^{ab}	0.89±0.02^{a}	0.77±0.04^{b}
Proteins (%)	0.53±0.03^{d}	1.99±0.17^{b}	1.28±0.02^{c}	3.50±0.13^{a}	3.33±0.02^{a}
Sugars					
Fructose (%)	44.42±3.56^{a}	16.91±1.46^{c}	29.44±1.78^{b}	7.90±0.49^{d}	9.62±0.32^{d}
Glucose (%)	52.13±4.21^{a}	15.61±1.23^{bc}	45.03±2.99^{a}	9.78±0.70^{c}	9.19±0.39^{c}
Sucrose (%)	1.68±0.16^{b}	57.99±4.65^{a}	9.37±0.47^{b}	59.56±3.29^{a}	62.86±2.58^{a}
Fibers					
NDF (%)	1.30±0.02^{e}	9.66±0.56^{c}	3.63±0.20^{d}	12.27±1.29^{b}	13.48±0.06^{a}
ADF (%)	0.77±0.07^{d}	8.02±0.97^{a}	2.68±0.09^{c}	6.08±0.47^{b}	7.67±0.10^{a}
ADL (%)	0.38±0.01^{b}	7.00±0.82^{a}	1.38±0.03^{b}	1.22±0.01^{b}	1.57±0.02^{b}
Hemicellulose (%)	0.53±0.02^{c}	1.64±0.15^{b}	0.95±0.11^{bc}	6.19±0.27^{a}	5.81±0.27^{a}
Cellulose (%)	0.39±0.02^{d}	1.02±0.21^{c}	1.30±0.12^{c}	4.86±0.52^{b}	6.10±0.51^{a}





Sensory profile and log-log plot of storage (G') and loss (G'') modulus values in dependence on frequency (f) for studied jams and spreads

Conclusion

The obtained results show that sweet maize cob (SMC) and black soybean seed coat (BSC) represent the substrates for the recapture of functional compounds and the development of functional foods. In addition, as a source of sugars and bioactive compounds, SMC and BSC could be a replacement of expensive berries in jams and spreads. Developed spreads had the highest content of proteins, total fibers, hemicellulose and cellulose compared to those in used commercial jams and spread. Based on our research, the content of total anthocyanins in SMC/BSC containing spreads parry to that in raspberry jam. Compared with the raspberry jam bought in Serbia, the SMC spread with 3.2% of BSC had about 1.3-fold higher content of total anthocyanins. In addition to anthocyanins, SMC/BSC containing spreads were relatively rich in p-coumaric, ferulic and 3,4-dihydroxybenzoic acids, as well as in catechin and quercetin.

Future research will be focused on the sucrose replacement by alternative sweeteners in order to obtain low caloric value spread with an acceptable texture, structure and flavor.

Address:
Slađana Žilić
www.mrizp.rs; szilic@mrizp.rs

UNIFood Conference
September 24th-25th 2021 University of Belgrade