Rice bran wax: a novel ingredient to structure edible oils

Vincenzo di Bari, Tim Foster, and Bettina Wolf

University of Nottingham, Food Sciences, Sutton Bonington Campus, Loughborough, LE12 5RD

EPSRC CENTRE FOR INNOVATIVE MANUFACTURING IN Food

Introduction

One of the main challenges being faced by the food industry is the reduction of *trans* and saturated triglycerides, i.e., the main ingredient used to provide structure to liquid oils. These change is driven by evidences suggesting that the consumption of these fats increases the risk of cardiovascular diseases and Type II diabetes. One of the novel route to obtain solid-like fat is represented by the use of the so called “organogelators”. These molecules provide solid-like structure to oils although containing little amounts of saturated fatty acids[1]. Among organogelators, rice bran wax (RBW) has proved to be one of the most promising novel ingredient due to its ability to structure oils at very low concentrations. Furthermore, RBW is produced in large quantities as by-product of rice bran oil production (Fig. 1).

RBW appears as a pale yellow pellet material (Fig. 2a) with a melting point of ~80 °C (Fig. 2b) (crystallisation ~78 °C).

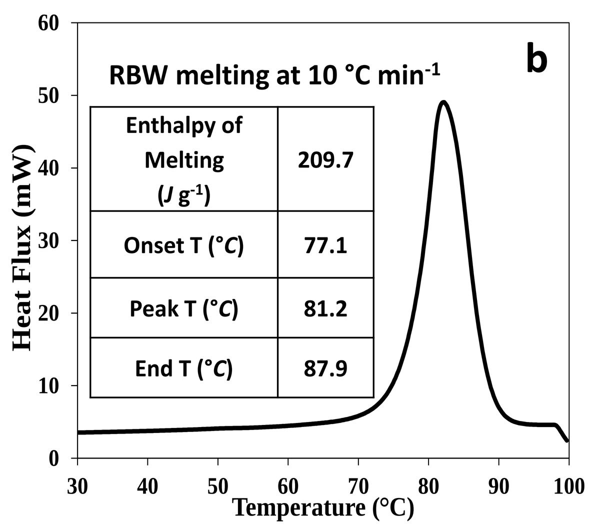

Fig. 2: Visualisation of RBW granules (a) and melting profile of a bulk wax granules at 10 °C/min (b). The values of temperature and enthalpy of melting are provided in the table.

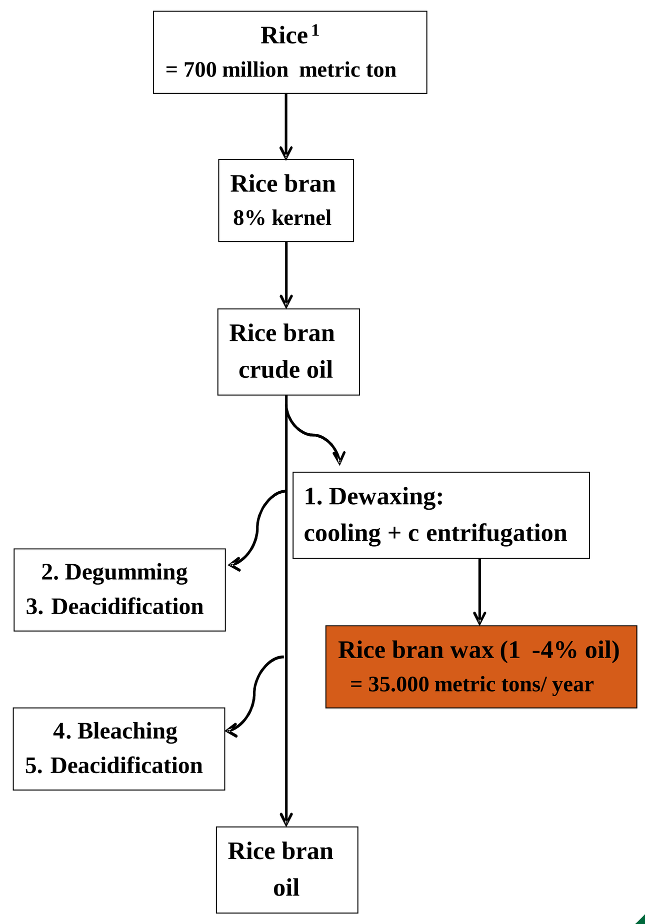

Fig. 1: Flow diagram of rice bran wax production

Oleogels preparation

Granules of RBW were added to sunflower oil (SFO) to the desired concentration (wt%) (Fig. 3a). Oleogels were prepared by heating the RBW and sunflower oil mixture to 90 °C (Fig. 3b and c) followed by cooling to ambient temperature (~25 °C) (Fig. 3d).

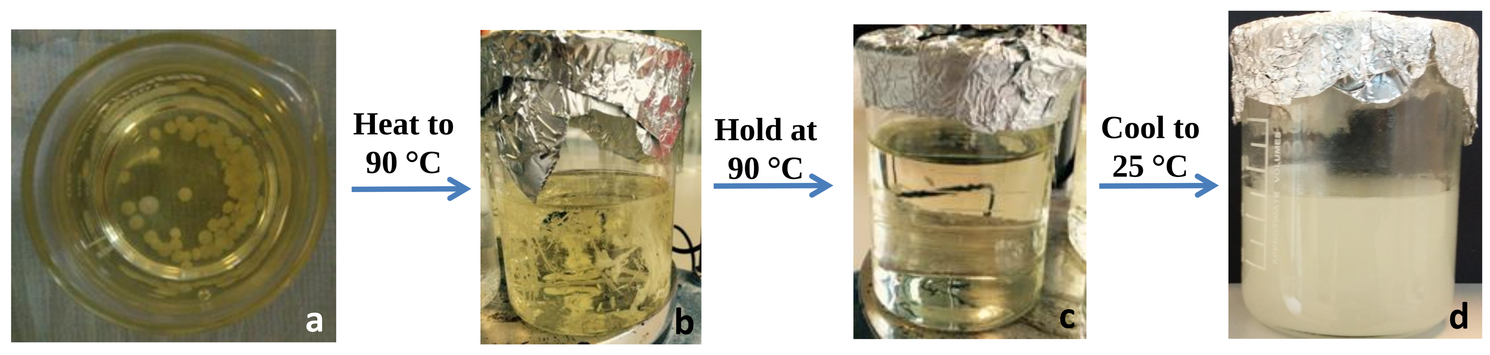

Fig. 3: Visualisation of RBW granules in SFO (a), melting of the wax granules (b) to obtain a clear liquid oil (c), and RBW based oleogel (1%, wt%)

Oleogels Macroscopic Behaviour

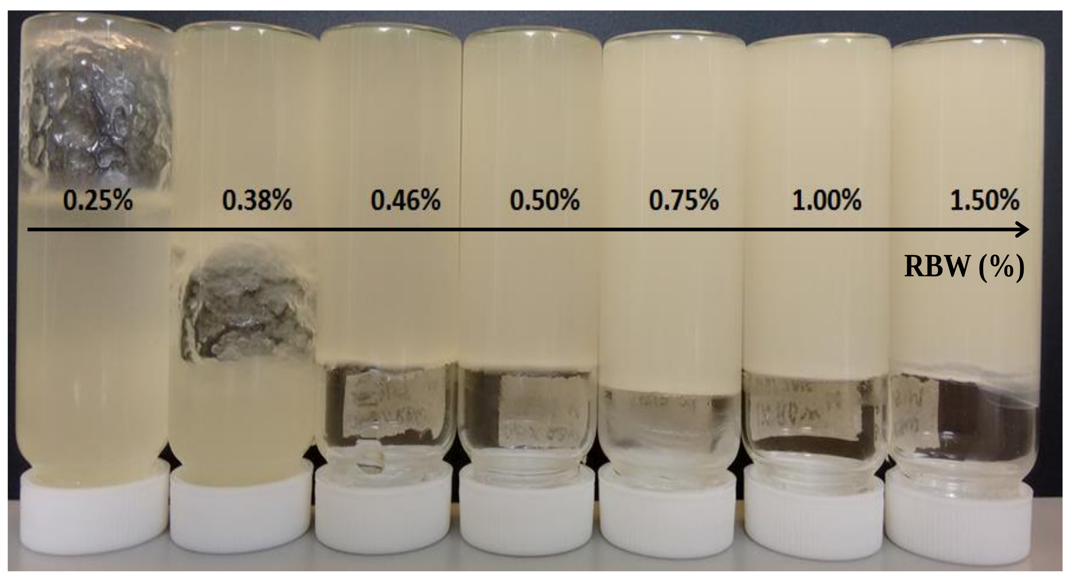

Fig. 4: Visualisation of RBW oleogels produced at increasing RBW concentrations.

The minimum concentration of wax to obtain a self-standing gel (i.e., which does not flow when inverting the vial) is 0.5% (wt%) (Fig. 4).

At concentration above 5% (wt%) the oleogels behaves as a solid-like material which can molded (Fig. 5)

Fig. 5: Example of a solid-like oleogels produced using 5% RBW

Oleogels Microstructural Properties

Oleogels Thermal Behaviour

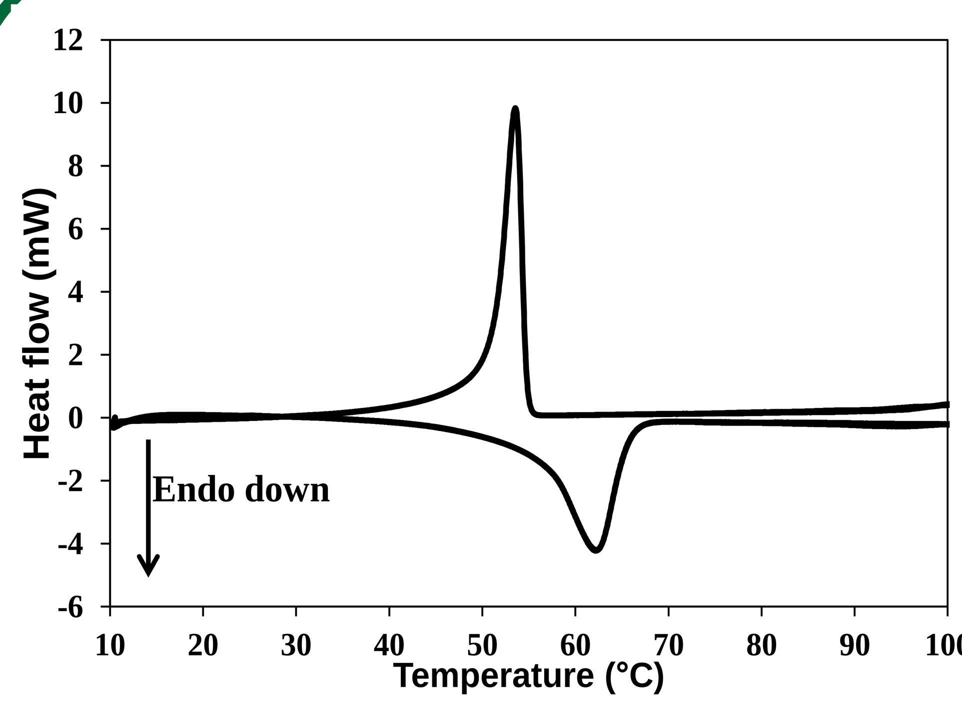

Fig. 6: Melting (downward) and crystallisation (upward) curves of 1% RBW oleogel. The graph contains two melting and crystallisation curves, respectively.

Thermal behaviour was characterised using a micro-DSC at 1 °C/min from 10 to 100 °C. 1% RBW oleogel shows thermo-reversible behaviour: on multiple melting-crystallisation cycles, curves perfectly overlap (Fig. 6). Values of enthalpies and peak of phase transitions are referred in Table 1.

	Enthalpy (J/g)	Onset T (°C)	Peak T (°C)	End T (°C)
Melting	2.451 (±0.01)	55.56 (±0.02)	62.23 (±0.06)	65.71 (±0.02)
Crystallisation	-2.442 (±0.001)	54.76 (±0.01)	53.53 (±0.00)	51.02 (±0.01)

Tab. 1: Melting and crystallisation parameters obtained for 1% RBW oleogel. Values are average and standard deviation of duplicate, respectively.

Oleogels Microstructure Visualisation

In Fig. 7 a polarised light image of the microstructure of a 3% (wt%) RBW oleogel is shown. The crystals (bright elements) are dispersed through the oil (dark areas) and have a needle-like or fibrous shape. This crystal morphology is believed to be responsible for the efficiency of RBW in forming oleogels

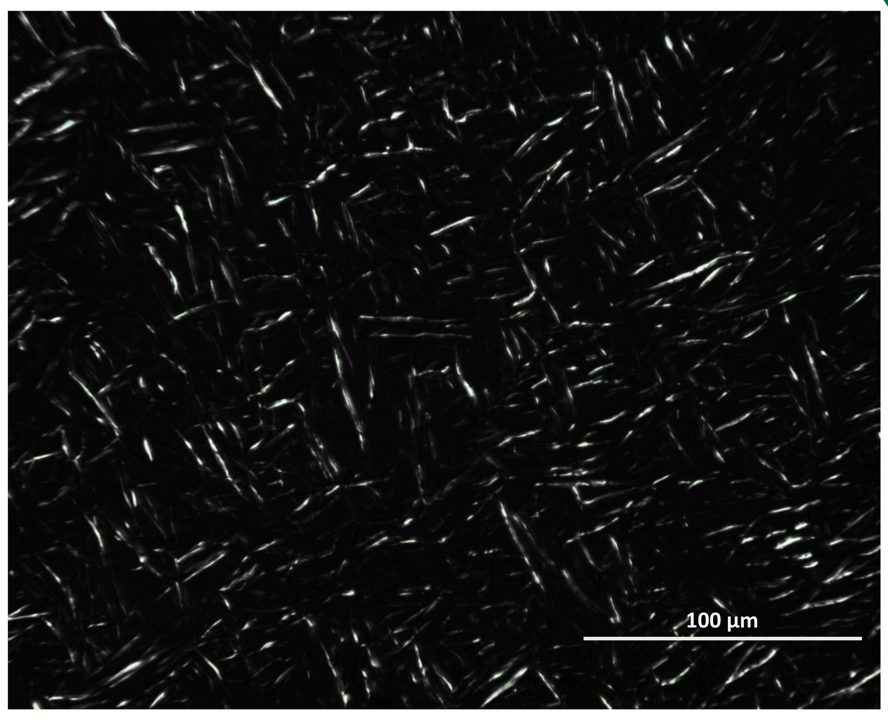

Fig. 7: Polarised light image of a 3% (wt%) RBW oleogels produced at increasing RBW concentrations

Oleogels Elastic Properties

Network elasticity (G’) evolution over time at various temperatures for 1% RBW oleogel (Fig. 8). The elasticity of the network decreases significantly at T ≥ 40 °C where some of the crystals may start to melt.

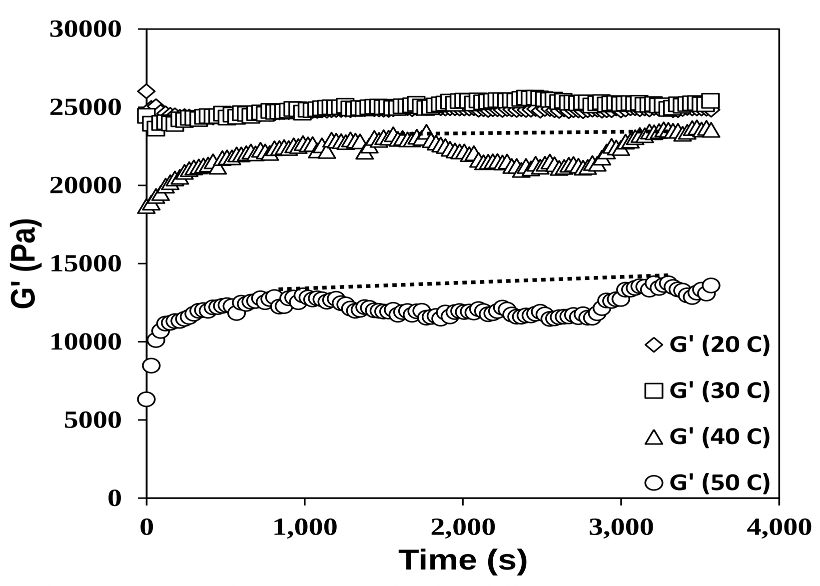

Fig. 8: G’ evolution over time for 1% RBW olegel at different .temperatures (see legend) using a shear strain of 0.01% and frequency of 10 rad/s

Amplitude sweep of 1% RBW oleogel at 20 and 50 °C (Fig. 9). The gel produced at 20 °C shows higher G’and a larger elastic region than gel produced at 50 °C.

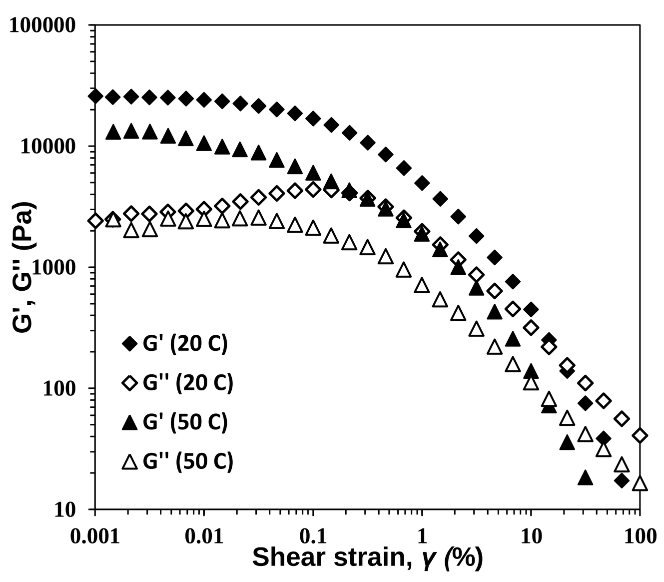

Fig. 9: Elastic (G’) and viscous (G’’) of 1% oleogels at 20 and 50 °C (frequency = 10 rad/s)

Conclusions and undergoing work

Results of this research suggest that RBW can be used as promising alternative to saturated fats for the structuring of edible oils, where the structuring elements have needle-like shape. In agreement with literature data[1], oleogels show to be thermoreversible viscoelastic materials.

Work currently undergoing is investigating the effect of cooling rate and application of shear on oleogel formation and mechanical properties. Incorporation of oleogels into emulsions is also being investigated.

References: [1]Blake AI, Co ED, Marangoni AG (2014) Structure and Physical properties of Plant Wax Crystal Networks and their relationship to Oil Binding Capacity. J Am Oil Chem Soc 91: 885-903

The University of Nottingham UNITED KINGDOM · CHINA · MALAYSIA
Loughborough University
UNIVERSITY OF BIRMINGHAM