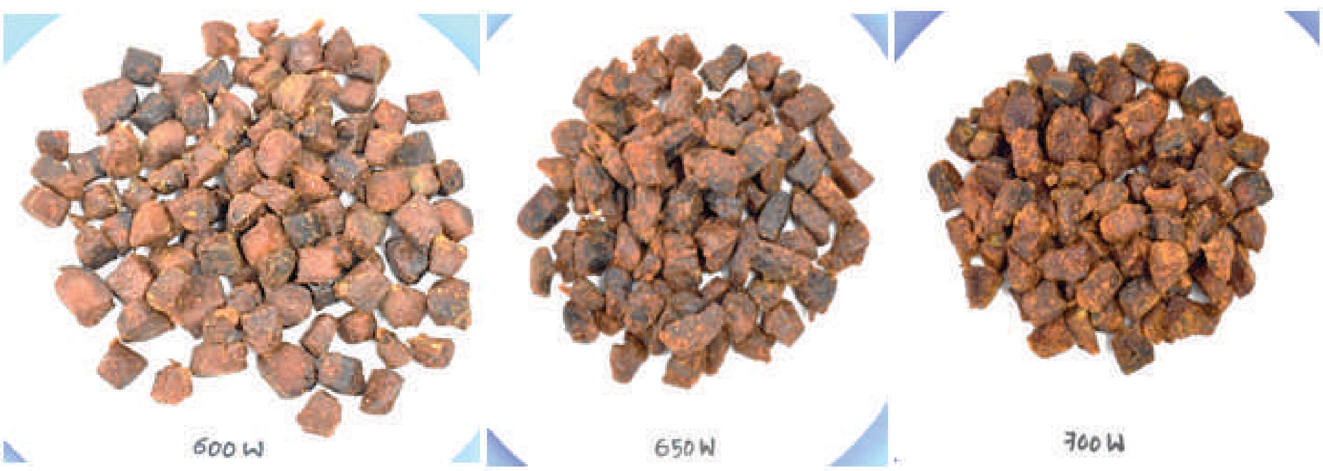
Physicochemical properties of microwave assisted dehydrated tuna chunks

Viji P.*, Jesmi Debbarma and Madhusudana Rao, B.
Visakhapatnam Research Centre of ICAR- CIFT, Visakhapatnam-03
**pankyammaviji@gmail.com*

Microwave heating is a dielectric processing in which heat is produced by molecular friction caused during the shifting of polar molecules from their equilibrium positions under an electromagnetic field. It is therefore a volumetric heating and is considered as an effective heating method to produce high quality foods. In the electromagnetic spectrum, microwave frequency lays between 300 MHz and 300 GHz and the frequencies of 915 MHz-2.45 GHz are utilized for scientific, industrial and medical applications (Hoogenboom et al., 2009). Microwave processing is gaining much interest in food industry as it has potential applications in pasteurisation, baking, blanching, disinfestation, cooking, drying, extraction, defrosting etc. Microwave drying has several advantages over conventional drying methods such as hot air or sun drying because of their deep penetrable nature and ability to generate homogenous heating at a faster rate inside the product. Many studies have shown that microwave drying is a shorter process of high efficiency resulting in high product quality without case hardening (Fu et al., 2015; Monteiro et al., 2018). Vacuum assisted microwave drying is a latest innovation in the field of drying technology which uses high rate of heat transfer by microwave at a controlled temperature under vacuum. Microwave vacuum drying has the potential to produce value added dried fish product and in this context, the present study was aimed to develop value added dried tuna chunks as a function of microwave power and to study the physicochemical properties of the dried products.

A low value tuna belonging to the genes Euthynnus was selected for the study. Boneless chunks of 2x2 cm were cut from the fillet and it was marinated with spices and salt. The marinated chunks were dried in batches in a microwave vacuum dryer at different radiation (power) levels (600 W (T1), 650 W(T2) and 700 W(T3) for 2 h., maintaining a vacuum of 700 mmHg in the drying chamber. The samples after dehydration were cooled and its physicochemical properties such as moisture content, a_w, rehydration, microstructure and lipid oxidation indices were evaluated.

The result of the experiment indicated that microwave power had significantly influenced the moisture content and a_w of the products. Moisture content of the chunks dried at 600, 650 and 700 W after 2 h was 44.69, 39.26 and 26.4%, respectively. Accordingly, a_w of the samples also differed significantly among the samples in a reverse trend with highest value in T1 (0.89) followed by T2 (0.85) and the lowest was in T3 (0.77). The result shows that



only T3 sample confirmed to quality standards of dried fish samples for a_w established (<0.78) by food safety and standards authority of India (FSSAI, 2016). Most spoilage bacteria and spoilage yeast require a water activity of 0.91 and 0.88, respectively but the spoilage mould can survive up to 0.8 a_w (Sen, 2005). In microwave drying, drying rate is determined by the ratio of microwave power to the amount of moisture to be removed (Scaman et al., 2015). The results of the study are in agreement with other studies reported previously for other food products (Doymaz et al., 2015; Chahbani et al., 2018).

Lightness (L*) and redness (b*) value of tuna chunks didn't vary significantly with microwave power because of similar exposure time in all experiments. Rehydration properties is an important quality parameter of dried products. Microwave vacuum drying process develops a porous structure inside the product which facilitate rehydration during soaking (Scaman et al., 2015). As given in Fig. 2, rehydration rate of tuna chunks increased with increase in microwave power. These findings can be explained with the help of SEM image which indicate a tight microstructure of T1 sample (Fig. 3a) dried at 600 W compared to a loosened microstructure of T3 sample (Fig 3b) dried at 700 W. A tight muscle structure and higher amount of moisture in T1 sample might have hindered the absorption of water during rehydration process resulting in lower rehydration rate. Microstructure of tuna muscle was influenced by the rate of water vapour evaporation during microwave heating. At higher power levels, the rate of evaporation is faster under vacuum and creates a more porous and loose structure.

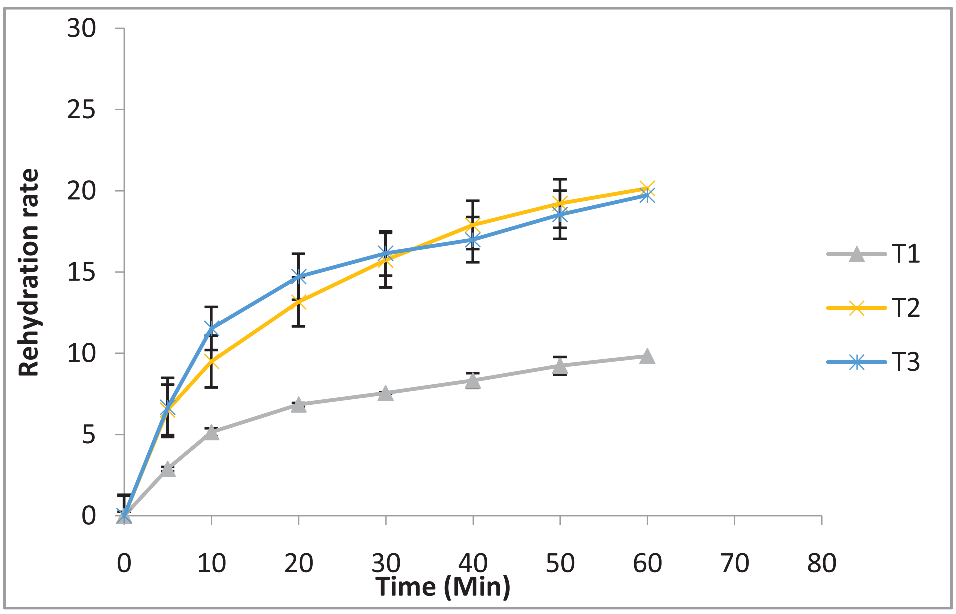


Fig. 2. *Rehydration rate of Tuna chunks dried at different microwave power*

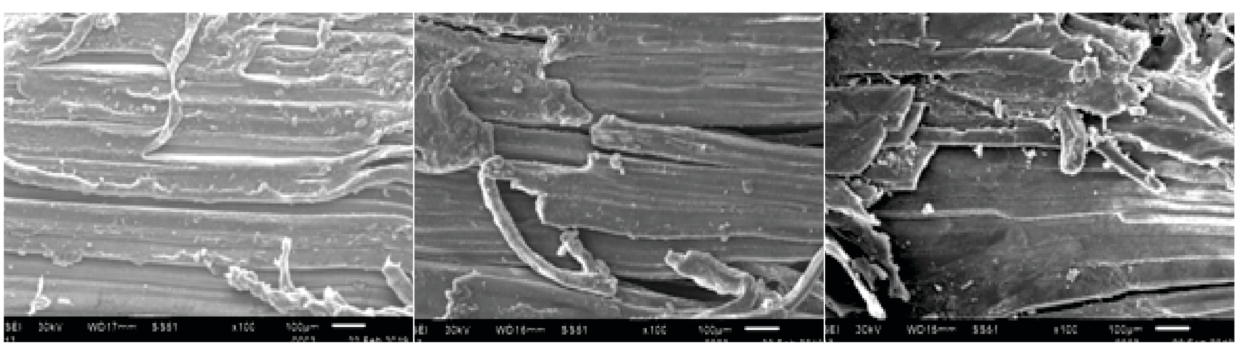


Fig.3 *Scanning electron microscope image of Tuna chunks dried in microwave vacuum dryer at a) 600 W, b) 650 W and b) 700 W*

Lipid oxidation is an inevitable chemical process caused by the oxidation fatty acids during drying process.In the present study, oxidation of lipids significantly increased with increase in microwave power. Peroxide values, the primary lipid oxidation index were 9.72, 10.17 and 16.94 mEQ O2/kg oil for T1, T2 and T3 samples, respectively. The mean value of TBARs, an index of secondary lipid oxidation was 0.65, 0.72 and 0.94 mg MDA/kg sample, respectively for T1, T2 and T3 samples. Under electromagnetic waves, fats and oils get extracted out of muscle fibre, making it susceptible to oxidation. Fatty acids of lipids are strong polar molecules and they exhibit strong dielectric properties depending on the composition of fatty acids which makes lipids more sensitive to oxidation and degradation under microwave. Abbas et al (2016) also noticed higher degree of oxidation in corn oil when the microwave power was raised from medium to high in a domestic microwave oven.

The results of the present study revealed that microwave power had significant influence on the physicochemical properties of fish product. Moisture removal was faster with increased powers indicating that microwaves of 650 W and above can be used to produce value added dried fish product. However, lipid oxidation is a constraint of drying at higher microwave power which needs to be controlled using heat stable antioxidants.

References :

Abbas A.M., Mesran, H.M., Latip, R.A., Hidayu O.N., &Mahmood, N.A. (2016). Effect of microwave heating with different exposure times on the degradation of corn oil. International Food Research Journal, 23, 842-848.

Chahbani, A., Fakhfakh, N., Balti, M.A., Mabrouk, M., El-Hatmi, H., Zouarib, N., &Kechaou, N. (2018). Microwave drying effects on drying kinetics, bioactive compounds and antioxidant activity of green peas (Pisum sativum L.). Food Bioscience, 25, 32–38.

Doymaz, I., Kipcak, A. S., &Piskin, S. (2015). Microwave drying of green bean (Phaseolus vulgaris) slices: drying kinetics and physical quality. Czech Journal of FoodSciences,33, 367-376

FSSAI (2016). Food Safety and Standards (Food Product Standards and Food Additives) Amendment Regulation, 2016

Hoogenboom R, Wilms TFA, Erdmenger T, Schubert US (2009) Microwave-Assisted Chemistry: a Closer Look at Heating Efficiency. Aust J Chem 62: 236-243.

Jiang, H., Liu, Z., & Wang, S. (2018). Microwave processing: Effects and impacts on food components. Critical Reviews in Food Science and Nutrition, 58, 2476-2489.

Scaman C.H., Durance, T.D., Drummond, L., & Sun, D. (2015). Combined Microwave vacuum drying. In: Sun D. (Ed.), Emerging Technologies for Food Processing (pp.427-441). New York: Academic Press