Effect of Magnetic Field Pre-treatment on the Fibre Content of Sweet Pepper and Fluted Pumpkin Leaves

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Received: 11-JAN-2022; Reviewed: 11-FEB-2022; Accepted: 26-APR-2022
https://doi.org/10.46792/fuoyejet.v7i2.771

ORIGINAL RESEARCH ARTICLE

Abstract- Sweet pepper (SP) and Fluted pumpkin leaves (FPL) vegetables contain fibre. Thermal pre-treatment (heat addition) of vegetables during processing has the tendency of reducing their qualities. Magnetic field (MF) as a non-thermal method of food pre-treatment is still grossly underutilized. Therefore, three (3) MF pre-treatment parameters (MF types, MF strength and pre-treatment time) were imposed on SP and FPL for the investigation of their effect on the fibre content of the two vegetables. A device working on electromagnetism principle was used to conduct the experiment designed. The average capacity and highest value of MF strength of the device are 20 g/min and 30 mT respectively. The fibre content of all pre-treated samples and controls (blanched and fresh) were analysed using standard procedures. Results showed that pre-treatment with MF led to fibre content of about 1.7 – 2.6% for SP and 6 – 10% for FPL; but samples of blanched SP and FPL had 1.8% and 7.5% respectively. MF pre-treatment in most cases led to better values of fibre than blanching for SP and FPL.

Keywords- Fibre content, Fluted pumpkin leaves, Magnetic field Pre-treatment, Sweet pepper.

1 Introduction

Sweet pepper (SP) and Fluted pumpkin leaves (FPL) are vegetables with scientific names, *Capsicum annum* and *Telfairia occidentalis* respectively. They both contain fibre, other nutrients and important medicinal properties needed for growth, development and maintenance of human body (Obeagu et al., 2014; Odewole and Olaniyan, 2016).

Fibre-rich foods have lower energy density, lesser fat content, richer micronutrients; and their consumption reduces several diseases in human beings (Dhingra et al., 2012). Fibre contents of vegetables and fruits are about 1.5 – 2.5 g/100 g on a dry weight basis (Dhingra et al., 2012). Processing operations can adjust or modify the fibre present in foods (Dhingra et al.,2012; Devi, 2015).

Pre-treatment is a unit operation in the processing of vegetables to value-added products. It is done primarily to aid the overall qualities of vegetables by improving/retaining their nutritional, sensory and functional properties in addition to microbial load reduction. It is a modification unit operation and the extent of modification is governed by method of pre-treatment, duration of pre-treatment and other properties (intrinsic/extrinsic) of the food to be pre-treated. Neeto and Chen (2014) classified food processing (also pre-treatment) methods into conventional and non-conventional.

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Section A- AGRICULTURAL ENGINEERING & RELATED SCIENCES
Can be cited as:
Odewole M.M., Olalusi A.P., Abdulsalam K.O., and Hammed A.G. (2022): Effect of Magnetic Field Pre-treatment on the Fibre Content of Sweet Pepper and Fluted Pumpkin Leaves, *FUOYE Journal of Engineering and Technology* (FUOYEJET), 7(2), 119-121. http://doi.org/10.46792/fuoyejet.v7i2.771

The conventional method (blanching, thermal pasteurization and thermal sterilization) of pre-treatment is somewhat popular; and it can either be thermal or non-thermal. The non-conventional method of pre-treatment which is sometimes called novel or emerging pre-treatment technology is not as popular as the conventional method; it could also be either non-thermal or thermal in nature. Typical thermal examples under the non-conventional methods are: microwave heating, *sous vide* and ohmic heating. Assurance of food of better quality is high with non-thermal pre-treatment (Barbosa-Canovas et al., 2005). Some typical examples of non-conventional pre-treatment methods that are non-thermal are: irradiation, Pulsed Electric Field, pulsed light, High Hydrostatic Pressure (Neeto and Chen, 2014) and magnetic field (MF).

Barbosa-Canovas et al. (2005) defined MF as a region in which a magnetic body is capable of inducing surrounding bodies. In 1985, magnetic field as a non-thermal method of preserving food was proposed for the first time (Barbosa-Canovas et al., 2005). When vegetables (and other foods) are placed within magnetic field for pre-treatment, the external magnetic field from either a permanent or temporary magnet (electromagnet) will interact with their structures. This interaction will lead to modifications responsible for quality adjustment. The guidelines given on the acceptable limits of exposure of different parts of human beings to magnetic field are 2 – 8T for head, trunk and limbs, and 400 mT for any part of the body (ICNIRP, 2009). Ajiboye et al. (2021) worked on the optimal selection of wire size for the coil and current required to design an electromagnetic component (which is capable of being used for different applied purposes). The optimum flux density and current obtained were 0.066T and 24A respectively.

Pre-treatment with MF has led to microbial load reduction of foods (Hayder et al., 2015; Haile *et al*., 2008; Lipiec et al., 2004), softening of meat (Ordonez and Berrio

2011), microstructures modification and adjustment of distribution of some food nutrients (Odewole et al., 2020) and enhancement of other quality properties of processed foods (Jia et al. 2015; Kyle, 2015).

The preceding information presented in the paragraph above on areas of application of MF for pre-treating food revealed that, MF utilization for food processing is somewhat scanty. Hence, the MF method is still grossly underutilized and its excellent advantage of non-thermal characteristics which will most likely lead to the making of pre-treated foods of better quality has not been substantially harnessed in the food processing sector. Therefore, this study investigated the kind of effect that three (3) MF pre-treatment parameters had on the fibre present in SP and FPL.

2 Materials and Methods

2.1 Materials

A device that generates MF for pre-treating SP and FPL: it was developed in Nigeria and available in University of Ilorin, Nigeria. The pre-treatment device was developed to work on the principle of electromagnetism. MF was experienced by the two vegetables inside the pre-treatment box of the device only when current is passing through the electromagnets of the device. The device produced static, pulse and alternating types of MF coupled with different MF strengths. A static MF was produced when the alternating current flowing from the power source to the MF space of the device was fully rectified; a pulse MF was produced with partial rectification of the alternating current. Furthermore, the alternating MF was produced without rectification (full or partial) of the alternating current. Also, electronic digital balance for weighing (OHAUS, Model 201, China), fresh SP and FPL were used.

2.2 Experimental Procedures

The two vegetables were procured cleaned and sizes reduced to irregular pieces with a knife. This was done to achieve better exposure of samples to the pre-treatment. After these, uniform experimental quantities (10 g and 100 g for SP and FPL respectively) were used separately for each run of the experiment. Each sample of the vegetable was carefully positioned in a rectangular shape pre-treatment box, and the box was placed within the magnetic field space of the device. Types of MF (Static, Pulse or Alternating), MF strength (5 - 30 mT) and pre-treatment time (5 - 25 min) were combined on the MF device following the experimental design and layout obtained from Design Expert software (version 6.0.6) as shown in Table 1. Blanching pre-treatment (soaking the two vegetables in hot water at 100^{o}C, bringing them out after 2 min and immediately pouring them in enough water at room temperature to stop the cooking process) and fresh samples served as the controls used for comparing with MF pre-treated samples. AOAC (2005) standard procedure was used to determine all the samples fibre content.

Table 1. Experimental design and layout

		SP/FPL	
		SMF/PMF	
SN		MFS (mT)	PT (min)
1	SMF-1/PMF-1	13.5	15
2	SMF-2/PMF-2	19.0	20
3	SMF-3/PMF-3	19.0	15
4	SMF-3/PMF-3	19.0	15
5	SMF-3/PMF-3	19.0	15
6	SMF-4/PMF-4	8.0	25
7	SMF-5/PMF-5	8.0	5
8	SMF-3/PMF-3	19.0	15
9	SMF-6/PMF-6	19.0	10
10	SMF-7/PMF-7	24.5	15
11	SMF-8/PMF-8	30.0	25
12	SMF-9/PMF-9	30.0	5
13	SMF-3/PMF-3	19.0	15
	SP/FPL		
	AMF		
		MFS (mT)	PT (min)
1	AMF-1	9.5	5
2	AMF-2	5.0	25
3	AMF-3	9.5	25
4	AMF-4	9.5	15
5	AMF-5	5.0	15
6	AMF-4	9.5	15
7	AMF-6	14.0	5
8	AMF-4	9.5	15
9	AMF-4	9.5	15
10	AMF-7	14.0	15
11	AMF-8	5.0	5
12	AMF-4	9.5	15
13	AMF-9	14.0	25

SMF-Static Magnetic Field; **PMF**- Pulse Magnetic Field; **AMF**-Alternating Magnetic Field;
MFS - Magnetic Field Strength; **PT**- Pre-treatment Time.
*Sample of interpretation of pre-treatment combination codes: SMF-1 is SMF @ 13.5 mT MFS and 15 min PT.

3 Results and Discussion

3.1 Fibre of MF Pre-treated SP and FPL

Figures 1 and 2 show (PMF and AMF are the next respective bars after each SMF, the last bar is for fresh or untreated sample) the fibre content of MF pre-treated SP and FPL. Many MF pre-treatment combinations (SMF-1, AMF-1, AMF-2, SMF-3, AMF-3, SMF- 4, PMF-5, AMF-5, SMF- 6, AMF- 6, AMF-7, SMF- 8, AMF-8, SMF- 9 and AMF- 9) significantly retained fibre than blanched sample at 5% probability value (as shown by the error bars). The highest value of about 2.6% fibre is present in SP at SMF-3 (SMF at 19 mT and 15 min), AMF-7 and SMF-8 while the blanched sample is about 1.8%. This might have been created by the much more severe damaging effect of blanching (heat addition thermal process) on the structure (location of fibre) than the non-thermal MF pre-treatment on the fibre of foods (Devi, 2015). The current result for SP is however not in agreement with 8% fibre of SP subjected to osmotic dehydration process in salt solution as a form of pre-treatment (Odewole and

http://doi.org/10.46792/fuoyejet.v7i2.771 http://journal.engineering.fuoye.edu.ng/

Olaniyan, 2016). For FPL, PMF-1 (PMF at 13.5 mT and 15 min), AMF-8 and PMF-9 have the peak fibre value of 10%; but blanched and fresh samples have about 7.5% and 7% respectively. Variations in the fibre values of SP and FPL pre-treated with MF may be attributed to the distinct characteristics of SMF, PMF and AMF (Bird, 2010).

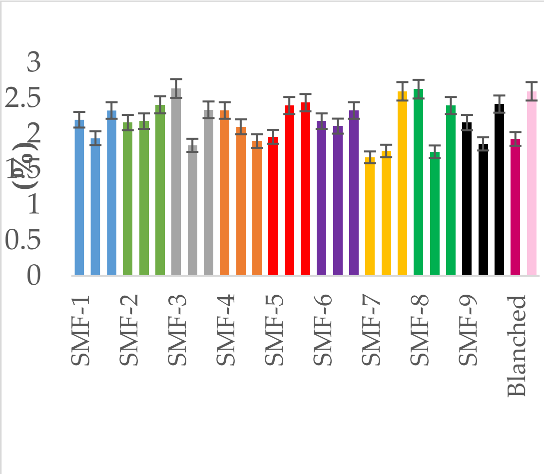

Fig.1: Fibre content of MF pre-treated SP

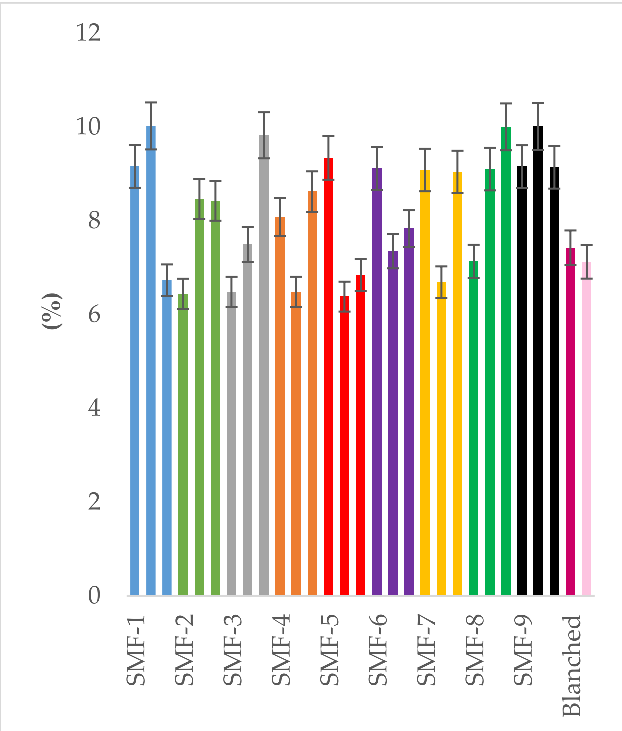

Fig. 2: Fibre content of MF pre-treated FPL

4 Conclusion and Recommendation

MF pre-treatment in most cases led to better fibre content of SP and FPL than blanching pre-treatment. Therefore, the MF method is a promising pre-treatment alternative that can replace blanching in the vegetable processing value chain. Process optimization of the MF pre-treatment method is highly recommended for future research.

Acknowledgement

Authors specially acknowledge Dr. A. T. Ajiboye of the Department of Computer Engineering, University of Ilorin, Nigeria and Dr. S. A. Oyetunji of the Department of Electrical and Electronics Engineering, Federal University of Technology, Akure, Nigeria for their immense contributions to the development of the MF Pre-treatment Device used to conduct the experiment.

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