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Characteristics of tiger nut milk pretreated with magnetic field

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Abstract: The thermal pre-treatment of tiger nut milk (TNM) via pasteurisation may have adverse effect on its quality characteristics. The use of a magnetic field (MF) to pre-treat TNM is a promising non-thermal method. This study investigated the effects of an MF pre-treatment on three (3) selected quality characteristics of TNM. Fresh TNM samples were pre-treated at 0.25–15.37 mT MF strength under static and pulse MFs for 10 minutes. All the samples were analysed for calcium, vitamin E and the microbial load, using standard procedures. The results showed that the MF pre-treatment led to an average 10% increment under pulse MF in the calcium of TNM; vitamin E reduced by an average of 2.28%. A partial reduction in microbial load of the TNM was achieved with the MF pre-treatment. MF is a viable quality-enhancing pre-treatment alternative for TNM. Studies should be conducted on more quality characteristics of MF pre-treated TNM.

Keywords: magnetic field; non-thermal; pre-treatment; quality; tiger nut milk

The tiger nut (*Cyperus esculentus lativum*) is a versatile perennial crop. Historically, it is cultivated in South Europe and West Africa for its small tuberous rhizomes which are used directly as a food or for making beverages (Belewu and Belewu 2007). Tiger nut milk (TNM) is derived from tiger nuts. TNM contains more vitamin E and digestive enzymes than animal-based milk (Bamishaiye and Bamishaiye 2011).

Food pre-treatment refers to operations conducted prior to primary processing to maintain the qualities and desired properties of food materials (Rahman and Perera 2007). The choice of the pre-treatment method is one of the factors that affects the final quality of foods. Foods can be subjected to either thermal or non-thermal pre-treatment processes or both. Non-thermal pre-treatments have been proven to have a minimal detrimental impact on food (Boateng 2024), while thermal pre-treatments adversely alter the organoleptic properties of foods (Roselló-Soto et al. 2018).

A magnetic field (MF) treatment is a non-thermal processing technology that interacts with the food structures (Wang et al. 2024). This will modify the food properties, and will lead to an improvement or reduction in quality. Research works exist on the use of MFs for pre-treating food materials (Ali et al. 2015; Odewole et al. 2020; Qian et al. 2021). However, the existing literature does not present convincing information on the use of MF for pre-treating TNM. This might be due to the categorisation of tiger nuts as an underutilised food raw material, with limited information on how their hidden values can be properly harnessed in the

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food systems. Hence, the objective of this study was to investigate the effect of types of MF and the MF strength on the characteristics (calcium, vitamin E and microbial load) of TNM.

MATERIAL AND METHODS

Experimental equipment and materials. The following major materials and equipment were used: an existing MF pre-treatment device developed in the University of Ilorin, Nigeria and located in the Department of Food Engineering, University of Ilorin, nutrient agar, a steam pressure steriliser (XFS-280A), an infrared thermometer, sample bottles, a stainless-steel container for pasteurisation, and fresh TNM produced from the yellow variety of tiger nuts.

Experimental design and layout. The experiment combined two independent variables, that is, the type of MF and different levels of magnetic field strength which are represented as factors A and B, respectively. Table 1 shows the experimental design and layout. The experimental design used was a 2 × 5 factorial experiment in a Randomised Complete Block Design (RCBD) with three (3) replicates. This made the total experimental runs to be 30, excluding the controls.

MF pre-treatment of TNM and quality analysis. All 30 measured samples of TNM, which were maintained at 4 °C from the point of collection, were subjected to MF pre-treatment with the use of the MF device (Figure 1). The experimental quantity used per run was 100 mL. The MF device basically works on the principle of electromagnetism (all details are in Odewole et al. 2023). The type of MF (static or pulse) and MF strength of various levels were selected and combined for the pre-treatment for a uniform pre-treatment time of 10 minutes. All the MF pre-treated samples, controls (pasteurisation at 70 °C for 10 min) and fresh samples were kept in well labelled sample bottles. They were immediately taken to the laboratory for the quality analysis, using the Association of Official Agricultural Chemists standard procedures (Latimer 2023). The total viable count (TVC) was determined according to the method in Kumala et al. (2021).

Table 1. Experimental design and layout

Magnetic field strength	B1 (static)	B2 (pulse)
A1 (0.25–2.11 mT)	A1 B1	A1 B2
A2 (2.93–5.41 mT)	A2 B1	A2 B2
A3 (5.72–8.42 mT)	A3 B1	A3 B2
A4 (5.96–9.22 mT)	A4 B1	A4 B2
A5 (13.20–15.37 mT)	A5 B1	A5 B2

A – magnetic field strength; B – type of magnetic field

RESULTS AND DISCUSSION

Quality characteristics of TNM

Calcium. Figure 2 shows the calcium profile of all the samples. Generally, the two types of MF have a significantly different effect on the calcium of TNM, as compared to the fresh and pasteurised samples. Calcium values (137.28–143.00 mg/100 mL) for the pulse MF at the used levels of MF strength (A1–A5) are higher than the values obtained for the static MF (112.31–123.00 mg/100 mL) at the same levels

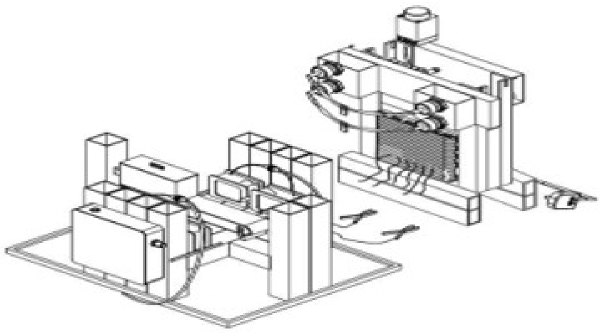

Figure 1. MF pre-treatment device
MF – magnetic field

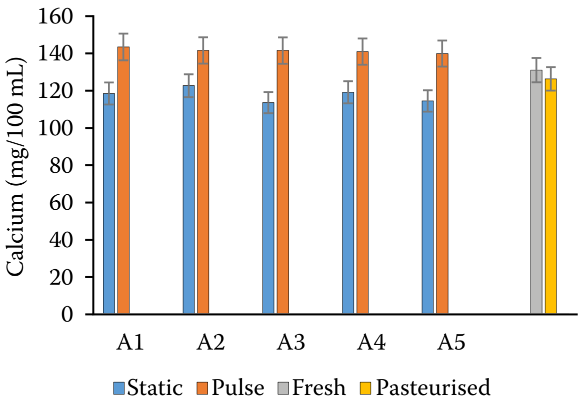

Figure 2. Calcium of the TNM
TNM – tiger nut milk

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of MF strength. The increase in calcium content might be due to the ion cyclotron resonance theory; which explained that the resonation of MF with ions increases the magnetic flux of ions into cells, thus leading to the liberation of the calcium (Dhawi et al. 2009).

Vitamin E. Figure 3 shows the vitamin E profiles of the MF pre-treated, fresh and pasteurised TNM. Generally, the vitamin E of TNM at static and pulse MFs are about 5.30–6.21 mg/100 mL and 4.35–4.94 mg/100 mL, respectively. These two values are lower than the values of the fresh (6.52 mg/100 mL) and pasteurised (6.07 mg/100 mL) TNM samples, but the values for static MF are not significantly different from the pasteurised values, unlike the pulse MF. The reasons for this are yet to be ascertained, although, there is an early indication that the static MF within the range of the used MF strengths performed better on the vitamin E of the TNM than the pulse MF.

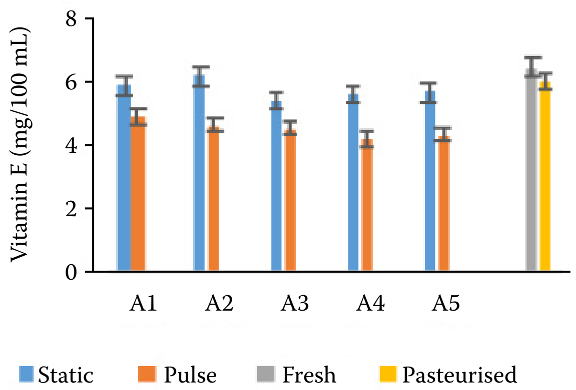

Figure 3. Vitamin E of the TNM
TNM – tiger nut milk

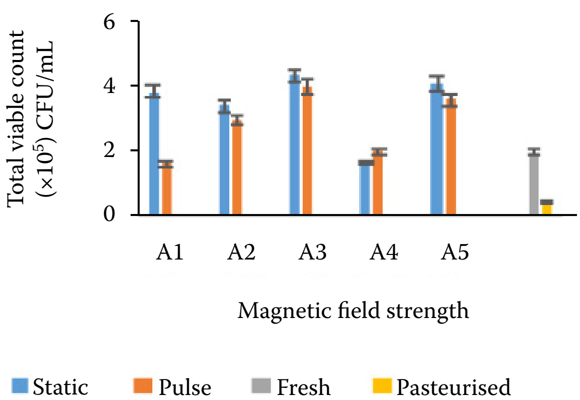

Figure 4. TVC of the TNM
TNM – tiger nut milk; TVC – total viable count

Microbial load. The TVC of the TNM (Figure 4) with the pulse MF at A1 (1.64×10^5 CFU/mL) and the static MF at A4 (1.66×10^5 CFU/mL) yielded TVC values lower than the fresh TNM (1.96×10^5 CFU/mL). This indicated the potential for the microbial reduction at certain factor combinations (Hayder et al. 2015; Liu et al. 2025). This partial success suggests that higher MF strengths (above 15.37 mT) or extended pre-treatment durations might be needed for greater microbial inactivation (Al-Khaza'leh and Al-fawwaz 2015).

CONCLUSION

The pulse MF significantly increased the Ca content of the TNM more than the static MF, pasteurised and fresh milk. Also, the vitamin E content of the static MF and pasteurised pre-treated TNM are not significantly different from each other. Furthermore, the MFs led to a partial reduction in the microbial load of TNM at some combination of factors. Overall, the findings revealed that the use of MF is a viable quality-enhancing pre-treatment alternative for TNM. Furthermore, (in-depth) studies should be conducted on more quality characteristics of MF pre-treated TNM, on the optimisation of the process and shelf-life.

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