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Impact of drying temperature and time on some physical properties of emu (*Dromaius novaehollandiae*) meat powder

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Abstract

Emu meat has gained attention due to its low-fat content, high protein levels, and rich vitamin composition. However, the perishable nature of meat necessitates proper preservation techniques to extend its shelf life. This study aims to explore the drying process of emu meat using a tray dryer and evaluate the impact of drying temperature and time on various physical properties of the resulting emu meat powder. The emu meat cooked at 40 °C for 10 minutes dried at 60, 70 and 80 °C temperature for 3, 4 and 5 hours were ground and sieved by sieve size of 500 µ. Average moisture content (% w.b), loose bulk density (g/cc) and tapped bulk density (g/cc) of meat powder dried at 60, 70 and 80 °C were in the range of 29.58 to 5.013, 0.886 to 0.872 and 0.949 to 0.932 respectively. L*, a*, b* of emu meat powder dried at 60, 70 and 80 °C were found to be 58.82 to 61.58, 5.98 to 4.51 and 18.31 to 17.01 respectively.

Keywords: Emu meat, meat powder, tray drying, physical properties and reconstititional properties

1. Introduction

Emu (*Dromaius novaehollandiae*) is the second largest bird in the world. Emu meat, characterized by its low fat content, is recognized for its nutritional value, including high protein content, vitamins, heme iron, and creatine offers nutritional benefits but faces challenges in terms of its texture, color, and palatability (Jakubowska *et al.*, 2019) ^[5]. The emu meat is 98% fat free, and the fat is 43% monounsaturated which helps to lower the “bad” LDL (Low Density Lipoprotein) cholesterol in the human body (Adewum *et al.*, 2011) ^[2]. However, the inherent perishability of meat necessitates the development of preservation methods to optimize its shelf life and nutritional value (Zhou *et al.*, 2010) ^[13]. Drying is a widely used technique for meat preservation, in which water is removed to increase the shelf life, lowers the cost of packaging, storage and transportation by reducing both the weight and volume of the final product. Tray drying is a commonly used method of drying food material.

Food powder properties are majorly classified as physical and chemical properties. Physical properties consist of the reconstitution properties, particle shape, diameter, size, density, porosity, surface characteristics and hardness (Baysan, U *et al.*, 2021) ^[2].

Understanding food density is crucial for studying material properties and optimizing industrial processes related to storage, processing, packaging, and distribution. Bulk density encompasses the total volume of both solid and liquid components, including the air or void spaces within a material. In contrast, true density refers solely to the volume of the solid and liquid components, excluding any air or void spaces. This distinction is essential for accurate assessments and applications in various food science and engineering context. (Figura, L., and Teixeira, A. A. (2007) ^[3]

2. Materials and Methods

2.1 Emu Meat Powder

Emu meat was cooked at 40 °C for 10 minutes, following the method described by Nithyalakshmi and Preetha (2015) ^[9].

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After cooking, the meat samples were drained and allowed to surface dry. Subsequently, the cooked emu meat was subjected to drying in a tray drier at various temperatures (60, 70, and 80 °C) for different durations (3, 4, and 5 hours). The drying chamber's temperature was maintained using a thermostat.

For the drying process, a total of 8 kg of cooked meat was evenly distributed across four trays, with each tray accommodating 2 kg of meat. The dimensions of each tray were 900 mm × 400 mm × 30 mm, and the trays were arranged in two rows with a clearance of 12.5 cm between them. Drying continued until the samples reached a constant weight, enabling an evaluation of their drying characteristics.

Once dried, the emu meat was ground using a domestic mixer equipped with a stainless steel blade. During this grinding process, heat was generated; therefore, sufficient time was allowed for the product to cool before continuing to ensure a fine powder consistency. The ground meat was then sieved through a handheld sieve with an aperture size of 354 µm (0.354 mm) to eliminate any coarse particles and to achieve a uniform particle size distribution.

2.2 Physical Properties

The sieved emu meat powder was analysed for its various physical properties such as moisture content (% w.b), bulk density (g/cm³), tapped density (ρ_t) (g/cm³) and colour.

2.2.1 Moisture Content

The moisture content of powder was determined by the hot air oven method by placing 2 g of powder at 105 °C drying temperature for 2 h. Thereafter, the sample was cooled in desiccators, weighed and re-dried in oven for 2 h. The process was repeated until a change in weight between the successive dryings at 2 h intervals was not more than 2 mg (Jittanit *et al.*, 2010) [7]. The weight loss after drying in the oven was used to calculate the moisture content of emu meat powder and was expressed on percentage wet basis (% w.b)

2.2.2 Bulk and Tapped Densities

The bulk density (ρ_b) of the emu meat powder was determined by measuring the weight of the powder and the corresponding volume. Approximately 20 g of powder sample was placed in a 100 ml graduated measuring cylinder. The bulk density was calculated by dividing the mass of the powder by the volume occupied in the cylinder. For the tapped density (ρ_t), the cylinder was tapped 100 times vigorously by hand (Jinapong *et al.*, 2008) [6].

2.2.3 Colour Measurement

The color of the emu meat powder was assessed using a HunterLab calorimeter. The CIE Lab color coordinates (L*, a*, and b*) were directly measured in a glass cuvette with a MinScan MS/Y/2500 spectrophotometer (Hunter Lab, Reston, VA, USA). Prior to measurements, the instrument was calibrated using a white calibration tile. The L* value represents lightness, a* indicates redness, and b* represents yellowness. The differences in L*, a*, and b* values between

the cooked treatments and the raw samples were evaluated using the ΔE metric. The chroma (C*) and hue angle (h) in degrees were calculated following the formulas outlined by Garcia-Segovia *et al.*, (2007) [4],

$$h = \arctan \left(\frac{b^*}{a^*} \right)$$

$$C^* = (a^{*2} + b^{*2})^{1/2}$$

where a hue angle of 0° corresponds to red and 90° to yellow.

2.3 Statistical Analysis

Cooked Emu meat was dried at various drying temperature such as 60, 70 and 80° C for different drying time; 3, 4 and 5 hour. Data were analysed by two way ANOVA using IBM SPSS statistic version 19.0 software. The significant differences between treatments were verified by Duncan multiple range test (DMRT) at P≤0.05. Values are referred in results as means ± Standard deviation

3. Result and Discussion

3.1 Impact of Drying Time and Temperature on Moisture Content of Emu Meat Powder

Drying studies and subsequent analysis demonstrated that increasing drying time and temperature resulted in a significant decrease ($p < 0.001$) in the moisture content of emu meat powder. The average moisture content (% w.b.) of the meat powder dried at 60, 70, and 80 °C for 3, 4, and 5 hours ranged from 29.58% to 5.01%. The greater the temperature differential between the drying medium and the meat particles, the higher the rate of heat transfer to the particles, facilitating moisture removal (Rawal and Masih, 2014) [10]. Higher temperatures corresponded with an increased drying rate, indicating an inverse relationship between drying time and moisture content. Nathakaranakule *et al.*, (2007) [8] reported a similar trend for chicken, where the drying rate increased with higher temperatures due to enhanced heat transfer.

3.2 Impact of Drying Time and Temperature on Densities of Emu Meat Powder

The bulk density and tapped bulk density of emu meat powder dried under varying temperatures and times are illustrated in Figure 1. Both loose bulk density and tapped bulk density significantly decreased with increasing drying temperature ($p < 0.05$) and drying time ($p < 0.001$). According to Walton (2000) [12], higher drying air temperatures generally lead to lower bulk and particle densities, resulting in a greater tendency for particles to exhibit hollow characteristics (Sarabandi *et al.*, 2014) [11]. The observed variation in loose bulk density ranged from 0.872 to 0.886 g/cm³, while tapped bulk density varied from 0.929 to 0.949 g/cm³, with tapped bulk density consistently exceeding loose bulk density across all drying conditions.

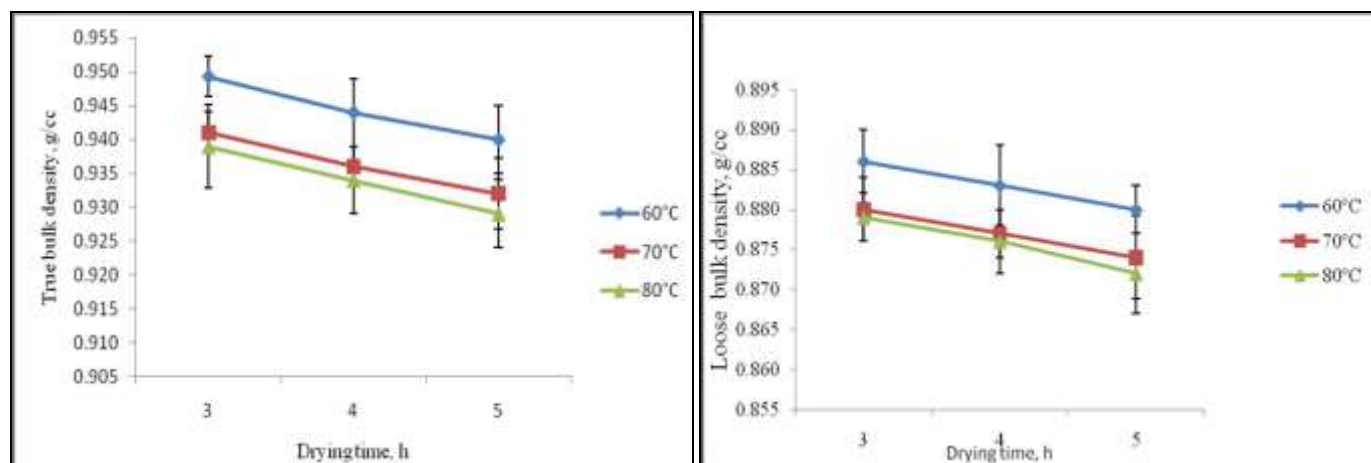
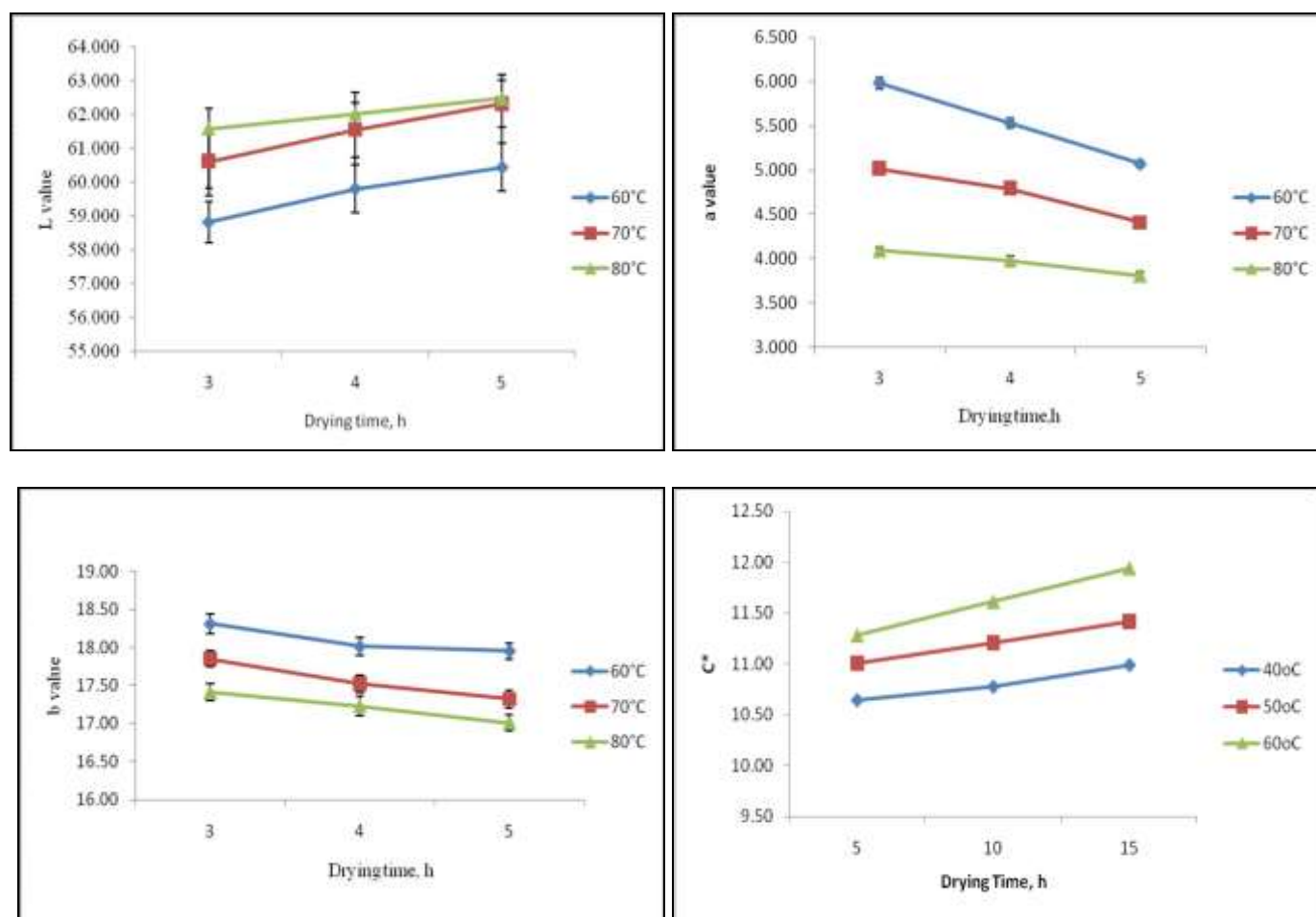


Fig 1: Effect of drying time and temperature on bulk and tapped densities

3.3 Impact of Drying Time and Temperature on Colour of Emu Meat Powder

The colour values such as L*, a* b*, C* and h value of emu meat powder dried under various tray drying temperatures and times are given in Figure 2. The lowest L* value was recorded at a drying temperature of 60 °C and a drying time of 3 hours. Both L* and b* values increased ($p<0.01$ and $p<0.001$, respectively) with elevated drying temperature and time,

indicating a transition from darker to lighter coloration, with a corresponding increase in yellowness. Conversely, the a* value decreased with higher drying temperatures and times, suggesting a degradation of the red color. Chrome value (C*) and hue value (h) were increased with increasing drying temperature and time. Analysis of variance confirmed that the effects of drying temperature and time were highly significant.



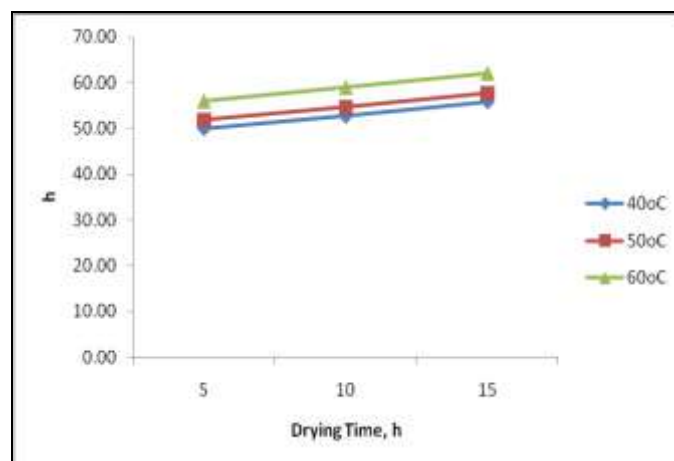


Fig 2: Effect of Drying Time and Temperature on Colour of Emu Meat Powder

Conclusion

This study established that moisture content, densities and color properties of emu meat powder were significantly influenced by tray drying temperature and time. The meat powder shows very low moisture content at 70 and 80°C. Tray drying temperature was a crucial factor influencing the final colour of emu meat powder.

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