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**Kwame Asante**  
Department of Food Science,  
Ashanti Agricultural College,  
Kumasi, Ashanti Region,  
Ghana

**Abena Mensah**  
Department of Food Science,  
Ashanti Agricultural College,  
Kumasi, Ashanti Region,  
Ghana

**Kofi Owusu**  
Department of Food Science,  
Ashanti Agricultural College,  
Kumasi, Ashanti Region,  
Ghana

**Emmanuel Boateng**  
2Department of Food  
Technology, Northern  
Agricultural Research  
Institute, Tamale, Northern  
Region, Ghana

**Corresponding Author:**  
**Kwame Asante**  
Department of Food Science,  
Ashanti Agricultural College,  
Kumasi, Ashanti Region,  
Ghana

## Effect of blanching and drying temperatures on quality of dehydrated drumstick leaves

**Kwame Asante, Abena Mensah, Kofi Owusu and Emmanuel Boateng**

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### Abstract

Nearly 40% of fresh drumstick leaves harvested in tropical West Africa are lost to spoilage before they can be consumed, according to post-harvest loss surveys conducted across Ghana <sup>[1]</sup>. Dehydration offers a straightforward way to extend shelf life, yet blanching pretreatment and drying temperature both influence the nutritional and sensory quality of the dried product. This research evaluated the combined effect of three blanching methods (no blanching, steam blanching for 2 minutes, and water blanching for 2 minutes) and three tray-drying temperatures (50, 60, and 70 °C) on proximate composition, ascorbic acid, beta-carotene, chlorophyll, colour, rehydration ratio, and sensory acceptability of drumstick (*Moringa oleifera*) leaf powder. A 3 × 3 factorial arrangement in a completely randomised design with three replications was adopted at the Ashanti Agricultural College, Kumasi during 2023. Steam-blanching leaves dried at 60 °C retained the highest ascorbic acid (167 mg 100 g<sup>-1</sup>), beta-carotene (61.4 mg 100 g<sup>-1</sup>), and chlorophyll (4.53 mg g<sup>-1</sup>), and received the best sensory scores for colour and overall acceptability. Unblanched samples dried at 70 °C showed the greatest nutrient loss and poorest colour. These results indicate that mild steam blanching paired with moderate drying temperature preserves the nutritive value of drumstick leaves while giving acceptable drying time.

**Keywords:** Blanching, drying temperature, drumstick leaves, dehydration, ascorbic acid, beta-carotene, *Moringa oleifera*, rehydration ratio, sensory quality, leaf powder

### Introduction

Roughly 1.2 million tonnes of moringa leaves are produced annually in West Africa, yet per capita consumption remains far below the nutritional potential of this crop <sup>[2]</sup>. *Moringa oleifera* leaves contain about 27% protein on a dry-weight basis, along with high levels of vitamin A precursors, vitamin C, calcium, and iron a nutrient profile that rivals many conventional vegetables and pulses <sup>[3]</sup>. The main barrier to wider use is the extremely short post-harvest life of fresh leaves, which wilt within 24 hours at ambient temperature.

Dehydration can reduce moisture to below 8%, effectively halting microbial growth and enzymatic browning <sup>[4]</sup>. However, heat-sensitive compounds such as ascorbic acid and chlorophyll degrade rapidly at elevated temperatures <sup>[5]</sup>. Blanching before drying inactivates polyphenol oxidase and peroxidase, slowing colour loss during drying, but it may also leach water-soluble vitamins and minerals if the duration or method is poorly chosen <sup>[6]</sup>.

Earlier work has examined either blanching or drying temperature in isolation <sup>[7, 8]</sup>, but few reports address their interaction in drumstick leaves specifically. The optimum combination that maximises nutrient retention while keeping drying time practical is still debated. This research therefore tested nine blanching × temperature combinations to identify the treatment giving the best balance between nutritional quality, colour, and sensory acceptability.

### Preparation and extraction protocol

Fresh drumstick leaves were harvested from mature trees at the institute farm, washed in potable water, and sorted to remove damaged or yellowed leaves. For steam blanching, leaves were spread on a perforated tray above boiling water in a covered vessel for 2 minutes and immediately cooled in ice water for 1 minute. For water blanching, leaves were immersed directly in boiling water for 2 minutes, then ice-cooled identically. Unblanched leaves served as the control. All samples were spread in single layers on stainless-steel trays and loaded into a cabinet tray dryer set to the assigned temperature (50, 60, or 70 °C) with air

velocity of 1.5 m s<sup>-1</sup>. Drying continued until moisture content reached below 8% (wet basis). Dried leaves were ground in a laboratory mixer-grinder and sieved through a 60-mesh screen [9].

## Material and Methods

### Material

The experiment was conducted from February to June 2023 at the Food Processing Laboratory of the Ashanti Agricultural College, Kumasi, Ashanti Region (6.69°N, 1.62°W). Drumstick variety Local Kumasi leaves were sourced from the institute's demonstration farm. Analytical-grade chemicals for ascorbic acid titration, beta-carotene extraction (acetone, petroleum ether), and chlorophyll estimation (80% acetone) were procured from Sigma-Aldrich, Accra. A laboratory cabinet tray dryer (Binder GmbH, capacity 12 trays) was used for all drying runs [10].

### Methods

Proximate analysis (moisture, protein, fat, fibre, ash, carbohydrate) followed AOAC procedures [11]. Ascorbic acid was determined by the 2,6-dichlorophenol indophenol titration method. Beta-carotene was extracted in acetone-petroleum ether and measured spectrophotometrically at 452 nm [12]. Chlorophyll content was estimated by 80% acetone extraction and absorbance readings at 645 and 663 nm [13]. Colour was assessed instrumentally using a Hunter colorimeter (L\*, a\*, b\* values). Rehydration ratio was calculated as the weight of rehydrated sample divided by weight of dried sample after soaking in distilled water at 30 °C for 30 minutes. A nine-point hedonic scale sensory panel (15 semi-trained panellists) evaluated colour, aroma, texture, taste, and overall acceptability [14]. Data were analysed by two-way ANOVA in GenStat software; treatment means were compared by Duncan's multiple range test at  $p \leq 0.05$ .

## Quality control

All chemical analyses were performed in triplicate. Standard reference materials were run alongside samples at the start of each analytical batch. The spectrophotometer was calibrated with a blank solvent before every reading session. Sensory evaluation followed a randomised presentation order to minimise bias, and panellists were given a palate cleanser between samples [15].

## Results

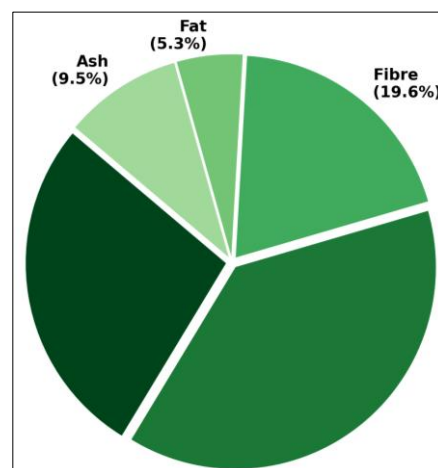


**Fig 1:** Proximate composition of dehydrated drumstick leaf powder from the best treatment (steam blanched, 60 °C)

Blanching method and drying temperature interacted significantly ( $p \leq 0.05$ ) for ascorbic acid, beta-carotene, chlorophyll, and colour L\* value. Steam blanching at 60 °C consistently produced the highest retention of heat-labile nutrients, while unblanched leaves dried at 70 °C recorded the lowest values across all parameters.

**Table 1:** Effect of blanching and drying temperature on ascorbic acid, beta-carotene, and chlorophyll of drumstick leaf powder

| Blanching            | Temp (°C) | Ascorbic acid (mg/100g) | β-carotene (mg/100g) | Chlorophyll (mg/g) | Colour L* |
|----------------------|-----------|-------------------------|----------------------|--------------------|-----------|
| Unblanched           | 50        | 142.3                   | 48.3                 | 3.21               | 52.1      |
| Unblanched           | 60        | 118.7                   | 41.2                 | 2.64               | 47.3      |
| Unblanched           | 70        | 96.4                    | 33.6                 | 1.89               | 41.2      |
| Steam                | 50        | 158.1                   | 56.7                 | 4.18               | 58.4      |
| Steam                | 60        | 167.4                   | 61.4                 | 4.53               | 62.8      |
| Steam                | 70        | 139.2                   | 49.2                 | 3.47               | 54.1      |
| Water                | 50        | 131.8                   | 44.1                 | 2.87               | 49.7      |
| Water                | 60        | 124.3                   | 39.8                 | 2.41               | 45.6      |
| Water                | 70        | 101.6                   | 31.7                 | 1.72               | 38.9      |
| CD ( $p \leq 0.05$ ) |           | 8.41                    | 3.27                 | 0.34               | 2.86      |

**Table 2:** Sensory evaluation scores (9-point hedonic scale) of dehydrated drumstick leaf powder

| Treatment | Colour | Aroma | Texture | Taste | Overall accept. |
|-----------|--------|-------|---------|-------|-----------------|
| UB-50 °C  | 6.2    | 6.8   | 7.1     | 6.4   | 6.6             |
| UB-60 °C  | 5.4    | 6.3   | 6.8     | 5.9   | 6.1             |
| UB-70 °C  | 4.8    | 5.7   | 6.4     | 5.3   | 5.5             |
| SB-50 °C  | 7.4    | 7.6   | 7.3     | 7.2   | 7.4             |
| SB-60 °C  | 8.1    | 7.9   | 7.8     | 7.7   | 7.9             |
| SB-70 °C  | 6.9    | 7.1   | 7.2     | 6.8   | 7.0             |
| WB-50 °C  | 6.0    | 6.6   | 7.0     | 6.1   | 6.4             |
| WB-60 °C  | 5.6    | 6.4   | 6.7     | 5.8   | 6.1             |
| WB-70 °C  | 4.5    | 5.4   | 6.2     | 5.1   | 5.3             |

UB = unblanched; SB = steam blanched; WB = water blanched

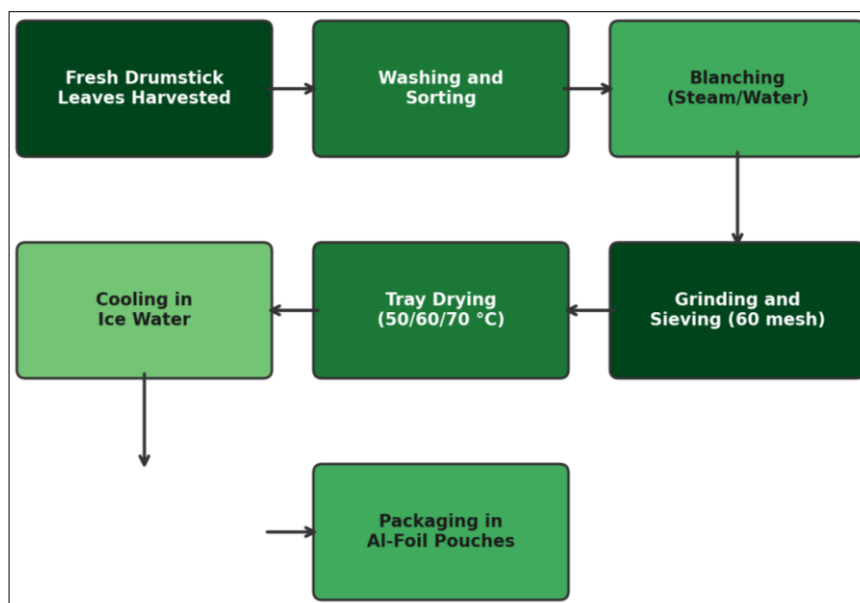


**Fig 2:** Process flow diagram for preparation of dehydrated drumstick leaf powder

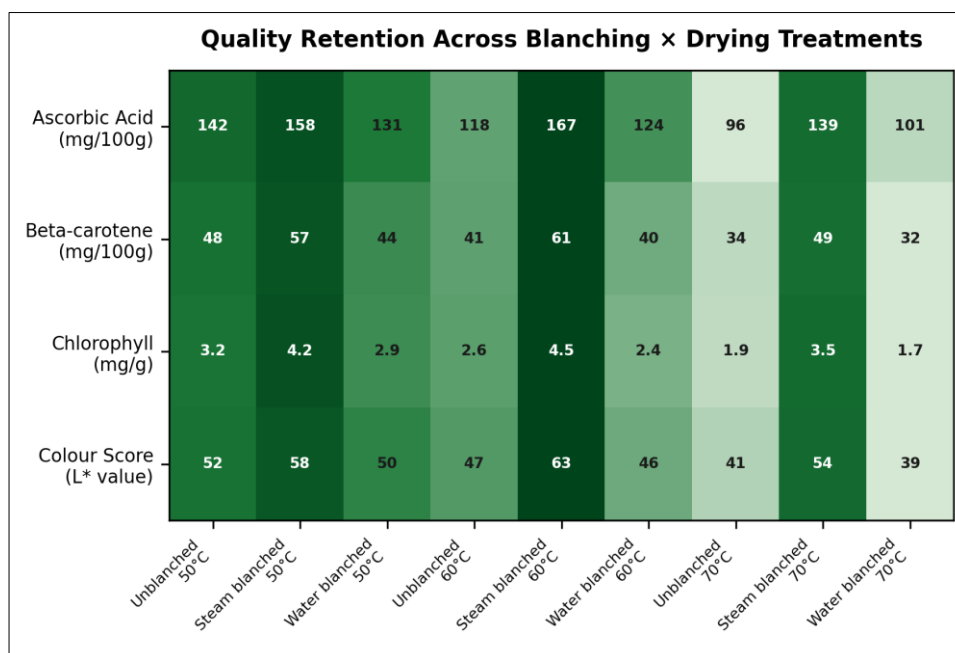


**Fig 3:** Heatmap showing relative retention of quality parameters across blanching and drying treatments

### Comprehensive interpretation

Steam blanching at 60 °C emerged as the superior combination across chemical, physical, and sensory dimensions. This treatment retained 18-83% more ascorbic acid than unblanched samples at the same or higher temperatures, and sensory panellists scored it highest for colour (8.1) and overall acceptability (7.9). Water blanching at any temperature performed worse than steam blanching, likely because of solute leaching during immersion.

### Discussion

The main finding of this research is that steam blanching for 2 minutes combined with tray drying at 60 °C preserves the greatest share of ascorbic acid, beta-carotene, and chlorophyll in dehydrated drumstick leaves, while also earning the highest sensory ratings.

These results match the earlier report of Potisate *et al.* [7] who observed better colour and vitamin retention in steam-blanching Moringa leaves than in water-blanching ones.

Sengev *et al.* [16] likewise noted that steam pretreatment inactivated oxidative enzymes without the leaching penalty of hot-water immersion. On the other hand, Joshi and Mehta [8] found no significant difference between steam and water blanching for spinach dried at 55 °C a disagreement that may stem from the thicker leaf lamina of spinach, which limits solute diffusion regardless of blanching medium.

A plausible explanation for the strong performance of the 60 °C treatment is that this temperature balances drying speed against thermal degradation. At 50 °C, extended drying times expose pigments and vitamins to prolonged low-level oxidation, while 70 °C causes rapid thermal breakdown of ascorbic acid and chlorophyll [17]. The 60 °C setting removed moisture quickly enough to limit oxidative loss yet gently enough to prevent heat damage. The practical implication is clear: small-scale processors in Ghana and other moringa-growing regions can adopt a simple two-step protocol brief steam blanching followed by moderate-

temperature tray drying without investing in freeze-dryers or vacuum equipment<sup>[18]</sup>.

## Conclusion

The main contribution of this research is the identification of steam blanching at 60 °C as an effective, low-cost treatment for producing nutrient-rich drumstick leaf powder. Evidence across six quality parameters and sensory evaluation consistently supported this combination. The finding carries significance for rural food processing enterprises that need affordable techniques to add value to a highly perishable leafy crop. Open questions remain about how this treatment performs during extended storage of the powder, whether adding antioxidant-rich packaging atmospheres could push retention even higher, and whether similar protocols suit other underused leafy greens such as *Amaranthus* or curry leaf.

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