Chapter 3
Effect of blanching temperature and time on physicochemical properties of bamboo shoot
3.1 Introduction

India is one of the rich genetic resources of bamboo with 136 indigenous exotic species under 23 genera under cultivation. Bamboo shoots are low in fat and calorie but rich in different nutrient like protein, vitamin, mineral, fiber etc. It also contains lignin and phenolic compounds which might contribute to its anti-microbial and anti-oxidant activity. In Assam, India bamboo shoots generally consumed either raw or processed because of its exotic taste, flavour and medicinal value. Some of the edible species that are suitable for processing available in Assam are *Dendrocalomvs giganteus* (Worra), *D. hamiltonii* (Kako), *D. strictus* (Lathians), *Melocanna baccifera* (Tarai, Arten), *Bambusa balcooa* (Bhaluka), *B. tulda* (Jati), *B. polymorpha* (Jama betwa, Betwa), *B. nutans* (Kotoha), *B. pallida* (Bijuli, Bakhal).

Heat processing is applied to various vegetables to increase its shelf life and nutritive value along with other properties while it also helps to reduce the anti-nutrient components. Blanching is a cooking process to stop various enzymatic reactions, to reduce microbial load in food, to soften tissues for an easier canning step and a shorter cooking time and to eliminate intracellular air to prevent oxidation. Heat treatment such as hot water blanching has been increasingly used to control pests, insects and fungi rot. It also induces resistance to chilling injury during storage at low temperature. Heat treatment inhibits disease incidences, respiration, ethylene production and various enzymatic activities of bamboo shoots during storage at 20 °C. Heat treatment like hot water blanching significantly delays the tissue lignification.

Time and temperature of blanching may helps to inactivate enzymes like peroxidase which is one of the most heat stable enzymes and often used as a marker of completion of blanching. Ascorbic acid, pigments like β-carotene are sensitive to heat treatment. Negi et al. has reported that KMS treatment during blanching successfully reduces the loss of chlorophyll, carotene and ascorbic acid content of savory beet, amaranth and fenugreek followed by the low temperature drying which helps in the better retention of the pigments and vitamin C. Blanching of soybean degrades its chlorophyll content but the loss nutritive including sugar, amino acid, and vitamin are minimal.
Blanching is a heat processing method applied to food and the changes in food during the heating process can be expected as loss in turgor in cells, loss of integrity of the cell membranes and partial degradation of cell wall components. Firmness of Brussel sprouts with increase in radical scavenging activity, total flavanoids and ascorbic acid content were observed after blanching operation at 50 and 100°C for 5 and 3 min respectively. This may be attributed to the loss of integrity of cell membranes and organelles. However, the loss of soluble sugar during post harvest treatment like hot water blanching is due leaching of sugar into water of soybean.

In regular practices bamboo shoot are boiled for before consumption for particular time. The boiling time is depending on locality, traditional practices and use for removal of bitterness of shoot. But the effect of boiling/ blanching time on nutritional components is not considered during process. With regards to removal of anti-nutrient components some valuable nutrients may get loss. The objective of this work is to find out the nutritional potential of some edible bamboo shoots of Assam and further investigate the change in different nutritional composition like protein, carbohydrate, fat, fibre and ash of fresh bamboo shoot after hot water blanching at different time-temperature combination. Different parameters like colour, texture, ascorbic acid, total phenolic content and radical scavenging activity of fresh and blanched sample were further analyzed.

3.2 Material and methods

3.2.1 Collection of raw materials and sample preparation

Bamboo shoots of *Dendrocalamus hamiltonni* (Kako), *Bambusa balcooa* (Bhaluka), *Bambusa pallida* (Makal/ Bijuli), *Bambusa tulda* (Jati) species were collected from Tezpur, Nagaon and Karbi Anglong in Assam, India. The shoots were transported to the laboratory within 24 hours of collection, where shoots were defoliated and washed. The unwanted parts were removed and the soft edible portions were stored at 4°C for further analysis. All the shoot samples were analyzed for moisture content, protein, fat, carbohydrate, crude fiber, ash, vitamin C, total phenol, antioxidant activity etc.
3.2.2 Blanching treatment

The shoots of *Bambusa balcooa* species were taken for this study. The soft edible portions were cut into uniform size of 1cm$^3$ and used for blanching treatment. For blanching treatment, shoots were immersed in a water bath at 75, 85 and 95 °C for 5, 10, 15, 20, 25 and 30 min and collected after reaching the pre-established time. After blanching, the samples were cooled in a cooling water bath for 2 min and excess moisture was removed from the surface of the shoot. An unheated sample was taken as a control. Fresh and blanched shoots were analyzed for moisture content, protein, fat, carbohydrate, crude fiber, ash, vitamin C, total phenol, antioxidant activity, texture, and colour. During preliminary experiments, the shoot was blanched at 75 °C for 5 min and checked for the presence of enzyme polyphenol oxidase and it was found to be absent. Therefore all temperature and time combinations were taken above this level.

3.2.3 Proximate analysis

Bamboo shoots were analyzed for moisture, protein, fat, carbohydrate, crude fiber, and ash according to the standard AOAC$^{12}$ methods. Fat in the samples was determined by extracting a known weight of powdered sample with petroleum ether using Soes plus (SCS6). Crude fiber and protein in the samples were determined using Fibro plus (FES06) and Kel plus apparatus (Pelican Equipment, Chennai, India) respectively. The nitrogen content was converted to protein by multiplying with a factor of 6.25.

3.2.4 Estimation of vitamin C (L-Ascorbic Acid)

Fresh and blanched bamboo shoots were weighed accurately to 5g and extracted in 4% oxalic acid solution by homogenization followed by centrifugation at 3000 rpm for 15 min. 5 ml of supernatant was collected and Vitamin C was estimated by titrating against 4% oxalic acid using 2, 6-dichlorophenolindophenols (DCPIP) as indicator.$^{13}$ Ascorbic acid standard solution was prepared for standard curve.
3.2.5 Estimation of total phenolic content

Bamboo shoot (1 g) was extracted with 10 ml of 80% methanol and centrifuged at 10000g at room temperature. Residue was reextracted (five times) with 80% methanol and centrifuged. Supernatant was collected and used for the analysis of total phenolics and antioxidant activity. The total phenolics in the sample were estimated using Folin-Ciocalteu reagent (FCR) procedure as described by Bray and Thorpe.\textsuperscript{14} Supernatant was evaporated to dryness and residue was dissolved in 5 ml distilled water. From this mixture 0.2-2 ml of aliquots were taken in different test tubes and volume of 3 ml was made using distilled water. FCR of 0.5 ml was added in it and after 3 minutes 2 ml of 20% sodium carbonate was added to each test tube. The mixture was heated on a water bath at 100ºC for 1 minute and then cooled. Absorbance was measured at 750 nm in spectrophotometer (Spectronic 20D+, Thermo Scientific, USA). The results are expressed as mg phenol/ 100 g of sample as Gallic acid equivalent.

3.2.6 Estimation of free radical scavenging activity

To check the antioxidative property of the bamboo shoot 0.1mM of 2,2 diphenyl 1-picrylhydrazyl solution (DPPH) was prepared. DPPH is a commercial oxidising radical used to be reduced by antioxidants. The disappearance of the DPPH radical absorption at a particular wavelength is monitored by the reduction in optical density. Blanched sample were extracted in methanolic (5 gm in 20 ml) solution and supernatant obtained was centrifuged at 5000 rpm for 30 min. After centrifugation 5 ml of supernatant and 5 ml of DPPH solution was kept at dark for 30 minutes for complete reaction to takes place. The anti radical activity was determined by spectrophotometer at 517 nm based on the reaction with stable radical DPPH.\textsuperscript{15} Control for the experiment was prepared by adding 5 ml DPPH and 5ml methanol. The DPPH radical scavenging activity was calculated according to the following equation (Eq. 3.1).

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\text{% Free radical scavenger activity} = \left(\frac{\text{Control absorbance} - \text{Sample absorbance}}{\text{Control absorbance}}\right) \times 100
\]

(3.1)
3.2.7 Colour measurement

The colour of bamboo shoots samples was measured using a Hunter Colour Lab (Ultrascan VIS, Hunter Lab. Inc., USA). The results were expressed in terms of $L$, $a$ and $b$ values. $L$, $a$ and $b$ values indicate lightness, redness (+)/greenness (–) and yellowness (+)/blueness (–), respectively.16

3.2.8 Texture measurement

Texture of fresh and blanched bamboo shoot were measured in Texture Analyser (TA-HDPlus, Stable Microsystems, UK) according to ASTM standard Method D882.17 The maximum force value is related to the firmness of the bamboo shoots. The measurements were performed in a Texture Analyser at a constant test speed of 0.5 mm/sec; however, pre-test speed and the post-test speed were 1mm/sec and 5mm/sec respectively. The trigger force of 5 g, P/2 cylindrical probe and 5kg load cell was used for test purpose.

3.2.8 Statistical analysis

The effect of blanching on nutritional component were performed taking three replicates and data were reported as mean ± SD. Single factor ANOVA was used to determine the critical difference of means, and variance among the different samples were checked at significance level $p \leq 0.05$.

3.3 Results and discussion

3.3.1 Nutritional analysis of bamboo shoot

Four different varieties of bamboo shoots were analyzed to check their nutritional potential (Table 3.1). Moisture content for all the species was recorded above 90%, which show the high perishability of shoot. The highest protein content of 3.42 g/100g was found in $B$. balcooa followed by 3.34 g/100g for $B$. pallida, 3.32 for $B$. tulda, and 3.28 g/100g for $D$. hamiltonii. Fat content of all species of shoots were found low and the values varies from 0.31 to 0.67 g/100g. $B$. tulda shoot contains highest (4.7
g/100g) amount of carbohydrate compared to other varieties. The carbohydrate of *D. hamiltonii*, *B. balcooa* and *B. pallida* had estimated 4.46, 4.08 and 3.89 g/100g respectively. The ash content in the shoots ranged from 0.82-0.90 g/100g of fresh shoot. It was highest in *B. pallida* and lowest in *B. Tulda*. L-ascorbic acid of four varieties of bamboo shoots were varies from 1.39 to 2.72 mg/100g and it was highest in *B. balcooa*. All the above results are comparable with the finding of Nirmala et al.\(^\text{18}\) on *Dendrocalamus giganteus* shoot.

Total phenolics and antioxidant activity of *B. balcooa* shoot were reported as 101.65 mg/100g and 27.12 % DPPH radical scavenging activity and it was high compared to all other species. The results of total phenolics and antioxidant activity are in line with the study of Satya et al.,\(^\text{19}\) but the values found during this study were comparatively less than reported values. In view of nutritional status of all four species of bamboo shoot, *B. balcooa* found to be rich in protein, vitamin C, good amount of carbohydrates, crude fiber, reducing sugar etc and high amount of total phenolics and antioxidant activity. However, *B. balcooa* extensively used for preparing different dishes and fermented products. Therefore, for all further studies the shoots of *B. balcooa* were taken.

**Table 3.1.** Nutritional composition of different species of bamboo shoot on fresh weight basis

<table>
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<tr>
<th>Parameters</th>
<th><em>D. hamiltonii</em></th>
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<th><em>B. pallida</em></th>
<th><em>B. tulda</em></th>
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<td>Moisture (g/100g)</td>
<td>90.71±1.46</td>
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<td>Protein (g/100g)</td>
<td>3.28±0.34</td>
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<td>Fat (g/100g)</td>
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<td>Ash (g/100g)</td>
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<td>Crude fiber (g/100g)</td>
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<td>Vitamin C (mg/100g)</td>
<td>1.45±0.14</td>
<td>2.72±0.18</td>
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<td>Total phenols (mg/100g)</td>
<td>88.23±4.38</td>
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<td>% DPPH free radical scavenging activity</td>
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<td>Reducing sugars (g/100g)</td>
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3.3.2 Effect of blanching on nutritional component

Nutritional component of fresh bamboo shoot was evaluated on the basis of blanching time and temperature and the results are shown in Table 3.2. From the table it can be observed that blanching time and temperature have significantly influenced the nutrient like protein, carbohydrate and reducing sugar ($p \leq 0.05$). However, the influence was less on ash and crude fiber. Protein (amino acid), fat and carbohydrate (sugar) are important not only for the nutritional point of view but it also adds flavor to the food. But these components were reduced with blanching time and temperature. Blanching time and temperature affects the biological value of protein by reducing its essential amino acid content. Blanching at 95$^\circ$C markedly reduces the protein content of bamboo shoot in comparison to 75$^\circ$C and 85$^\circ$C. At high temperature most of the labile protein gets denatured. Crude fat have been significantly affected after blanching treatment ($p \leq 0.05$). Fresh bamboo shoot contains 0.52 g/100g fat, after blanching for 30 min was reduced to 0.38, 0.28 and 0.19 g/100g at 75$^\circ$C, 85$^\circ$C and 95$^\circ$C respectively. Duration of blanching treatment had been also affected the fat content. Blanching for 5-10 min has better retention of fat than long duration blanching for 20-30 min. The reduction in fat might be due to melting and oxidation of fat at high heat treatment, which would allow it to transfer from sample to water during blanching at higher temperature and increasing time.\textsuperscript{20}

Variation in carbohydrate and reducing sugar after hot water blanching was recorded and it can be observed that the maximum loss corresponds to the high temperature long duration blanching of 95$^\circ$C for 20-30 min. Blanching treatment has a significant reduction ($p \leq 0.05$) in carbohydrate and reducing sugar components by 4.08 to 2.25 g/100g and 1.33 to 0.87g/100g respectively. Most of the sugar like glucose, fructose and sucrose was destroyed during hot water blanching. The molecular size of sugar and duration of blanching affected the content of sugar and loss of this water soluble sugars might be correlated with the leaching into water during blanching.\textsuperscript{9} Crude fiber and ash content were almost remaining unaffected with blanching temperatures and time.
### Table 3.2. Effect of blanching on different nutritional component

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#### 3.3.3 Effect of blanching on L-ascorbic acid content

Ascorbic acid content in fresh bamboo shoot was found to be 2.72 mg/100g. Blanching temperature significantly reduced the ascorbic acid content of bamboo shoot (p ≤ 0.05) (Fig. 3.1). Retention of ascorbic acid is higher in 75°C which was gradually reduced at 85 and 95°C. It is also affected by the duration of blanching. Blanching for short time (5-10 min) retain more ascorbic acid while at 20-30 min the losses were high. Loss of ascorbic acid might be due to the leaching of content into water. L-ascorbic acid is very soluble in water and are not stable at high temperature. Vegetable tissue suffers...
Effect of blanching temperature and time on physicochemical properties of bamboo shoot

various changes in cell permeability and vacuole membrane upon high temperature treatment, which leaches the nutrients. Similar results were found on by Olivera et al. (2008-10) on Brussels sprouts during blanching. However, disruption of cell during blanching leads to the migration of ascorbic acid into the blanching medium which may accounts for the high loss of ascorbic acid from the vegetables.21

![Graph showing the effect of blanching temperature on ascorbic acid content.](image)

**Fig. 3.1.** Effect of blanching temperature on ascorbic acid content

### 3.3.4 Effect of blanching on total phenolic content

Fresh bamboo shoot showed the total phenolic content of 101.65 mg/100g which was get degraded during blanching operation. The total phenolic value for the samples blanched at 75, 85 and 95°C for 10, 20 and 30 min are indicated in the Fig. 3.2. The results clearly indicate that there is a significant loss of phenolic content with increase in temperature and duration of blanching (p ≤ 0.05). Maximum loss can be observed at 95°C for 30 min of blanching and highest retention of phenolic reported at 75°C for 5 min. At the end of blanching, the retention of phenolic at 75, 85 and 95°C were 59.57, 45.26 and 39.34 mg/100g respectively. High intensity heat treatment leads to the maximum loss of phenolic content which may be due to several reasons like thermal degradation, leaching or diffusion of component into water etc.22 Similar results were reported by Jaiswal et al.23 during blanching of cabbage. Enzyme like PAL
(phenylalanine ammonia-lyase), PPO (polyphenol oxidase) plays an important role during phenol synthesis in plant. PAL is the first key enzyme in the biosynthesis of the phenolic component. Increase activity of PAL leads to the increase in synthesis of phenols. Thus it can be attributed that during heat treatment these enzymes gets inactivated which leads to the reduction of phenolic components.

![Graph showing effect of blanching time on total phenolic content](image)

**Fig. 3.2.** Effect of blanching temperature on total phenolic content

### 3.3.5 Effect of blanching on free radical scavenging activity

DPPH is a stable free radical which is used to interpret the antioxidative property of sample. Antioxidant property of fresh and blanched sample were assayed and shown in Fig. 3.3. The profile obtained after blanching of bamboo shoot, showing a decreasing antioxidative activity after blanching operation. Graph depicts the significant loss of antioxidative property as the temperature and time of the blanching increases (p ≤ 0.05). Antioxidative property of bamboo shoot was closely related to the presence of different phytochemicals, phenols, tocopherol, ascorbic acid and their synergistic effects. Antioxidative capacity cannot be correlated with a single compound, but attributed to synergistic and additive effects between different inherent phytochemicals. Different studies have suggested that not only the amount of the phenolic content but molecular structure also affects the antioxidative property.
Fig. 3.3. Effect of blanching temperature on free radical scavenging activity

3.3.6 Effect of blanching on colour of the bamboo shoot

Colour is one of the most important parameter which indicates the quality and freshness of any food. Colour parameter of fresh and blanched bamboo shoot at different time and temperature are shown in Fig. 3.4. The L value depicts the lightness of the sample. Fresh sample has higher L value (71.26) comparative to blanched sample which were decreased further as the blanching time and temperature increased. Bamboo shoots blanched at 75°C and 85°C have shown a little colour change with increase in blanching time. While there were more changes in colour values were observed in the sample blanched at 95°C. At higher blanching temperature (85-95°C), excessive loss in the natural colour pigments and decreased in lightness of the shoot were observed. This might be due to the non enzymatic browning of the bamboo shoot due to high temperature treatment. Gonçalves et al.\textsuperscript{22} follows the same trends of decreased in L and a value with increasing blanching time for carrot, but b value were not in line with this study. In this case b value get increased with temperature and time this might be due to more yellowness form on blanched shoot at high temperature. Blanching alters the chloroplast integrity where the chlorophyll pigments are embedded and results in the formation of pheophytin as the time and temperature of blanching progresses.\textsuperscript{26}
Effect of blanching temperature and time on physicochemical properties of bamboo shoot

Fig. 3.4. Effect of blanching temperature on colour of bamboo shoot
3.3.7 Effect of blanching on texture

Bamboo shoot firmness continuously decreases with the increasing time and temperature of blanching. Fresh bamboo shoot exhibited firmness of 547.83 g. The texture degradation curve of blanched bamboo shoot at various temperatures (75-95°C) and time (5-30 min) are shown in Fig. 3.5. Textural loss was found to be more in first 5 minutes of blanching which consistently increased with increase in temperature and time. Most of the degradation of texture was occurred during 30 minutes of blanching at 95°C. Softening of tissue after hot water blanching is due to the decomposition of pectin content with some other biochemical changes. Significant changes in the textural properties of blanched bamboo shoot can be observed at different temperature and time (p ≤ 0.05). Bamboo shoots blanched for 5 to 10 min have shown better retention of textural properties than 20 to 30 min of blanching. At the end of 30 min of blanching, the retention of texture at 75, 85 and 95°C were 70.74, 59.84 and 46.86% respectively. The textural behavior is consistent with the result found by Zheng et al.1

![Figure 3.5](image)

**Fig. 3.5.** Effect of blanching temperature on texture of bamboo shoot
3.4 Conclusion

Blanching in hot water was carried out in order to inactivate various enzymes and to improve the quality and to increase shelf life of vegetable. Effect of hot water blanching on different physical and nutritional quality like total soluble sugar, protein, dietary fiber, fat vitamin, ascorbic acid, phenolic content and radical scavenging activity were evaluated. Blanching of bamboo shoot leads to degradation of various nutrients. Loss was maximum at 95°C for 20-30 min and minimum at 75°C for 5-10 min of blanching. Texture was also affected by the blanching operation. Blanching results in soft texture, while there was decreased in lightness and increase in greenness and yellowness observed. Loss of antioxidative property, total phenolic content and ascorbic acid might be related to the migration or leaching of component into the water. Proper combination of time and temperature of blanching is very important to retain the nutrients and quality of bamboo shoot. Low temperature and short time blanching have better retention of the entire nutritional component along with colour and textural properties. Therefore low temperature treatment with short duration was most suitable method of blanching.
References


3. NMBA, *A list of Bamboo species found in Assam*. National mission on bamboo application.


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