THE OPTIMAL SEED INCUBATION TEMPERATURES AND TIME FOR AMYLASE ACTIVITY IN FINGER MILLET MALT.

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Introduction

❖ Finger millet is one of the few special species that currently support the worlds food supplies. It is a staple food upon which millions of people depend on in some parts of Eastern and Southern Africa (Andriotis et al., 2016).

❖ Of all the worlds cereal grains, finger millet is second only to barley in its ability to hydrolyze starches (Amara, 2003).

❖ Its annual world production is at least 4.5 millions tons of grain of which Africa produces perhaps 2 millions (Arch, 2005).

❖ Its grain can be stored for years without insect infestation, this makes prolong its shelf life better than other cereal grains.
**Nutritional composition of finger millet/ 100g**

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbohydrates:</td>
<td>67.5g</td>
</tr>
<tr>
<td>Protein:</td>
<td>11.6g</td>
</tr>
<tr>
<td>Phosphorus:</td>
<td>296mg</td>
</tr>
<tr>
<td>Magnesium</td>
<td>137mg</td>
</tr>
<tr>
<td>Potassium:</td>
<td>307mg</td>
</tr>
<tr>
<td>Iron:</td>
<td>8.0mg</td>
</tr>
<tr>
<td>Calcium:</td>
<td>42mg</td>
</tr>
<tr>
<td>Carotene:</td>
<td>132mg</td>
</tr>
<tr>
<td>Dietary fiber:</td>
<td>11.3g</td>
</tr>
<tr>
<td>Essential Amino Acids:</td>
<td>1.86g</td>
</tr>
</tbody>
</table>

Source: Gopak, 2012.
Diagrammatic representation of the health benefits of finger millet

**Health Benefits of Finger millet**

- Beneficial in detoxifying body
- Lowers bad cholesterol level
- Prevents onset of breast cancer
- Helps to prevent type 2 diabetes
- Effective in reducing blood pressure
- Helps to protect against heart diseases
- Aids in treating respiratory conditions such as asthma
- Helps to optimize kidney, liver and immune system health
- Reduces risk of gastrointestinal conditions like gastric ulcers or colon cancer
- Eliminates problems like constipation, excess gas, bloating and cramping

*Nutrients*  
- Carbohydrate 27%  
- Protein 20%  
- Calories 18%  
- Dietary Fiber 11%

*Vitamins*  
- Thiamin 26%  
- Niacin 22%  
- Folate 20%  
- Vitamin B6 10%

*Minerals*  
- Copper 35%  
- Phosphorus 27%  
- Magnesium 26%  
- Iron 16%

*% Daily Value per 100g. For e.g. 100g of millet provides 35% of daily requirement of copper.*

Problem statement

• Despite the fact that it is more nutritious, cheaper and available all year round, finger millet is still regarded as an underutilized crop majorly because of the poor perception of people towards it.
Hypothesis

• The malting power of finger millet is similar to that of barley hence; finger millet is a promising candidate for replacement of other malted foods such as barley, pearl millet and sorghum, which had been implicated in gluten allergy (Devi et al., 2014; Onwuka et al., 2019).

• Finger millet malt can produce highly acceptable alcoholic and probiotic beverages.
Malting

• Malting is a process of germinating cereal seeds under controlled conditions in order to activate the endogenous hydrolytic enzymes (Coulibaly & Chen, 2011).

• The main goal of malting is for the cereal grain to synthesize the enzymes needed for converting starch into fermentable sugars (McGovern, 2009).

• This could be achieved following three major steps: steeping, germination and kilning (McGovern, 2009; Falk & Ulrich, 2008).
**Aim of study**

- The study aimed to produce finger millet malt as a fermentable substrate for production of malted based foods or fermented drinks.
Objectives of study

• To incubate finger millet under different temperatures and determine the optimal seed incubation temperature and time for maximum amylase activity.

• To monitor germination of finger millet seeds by growth in radicle.

• To examine the effects of incubation temperature and time on α-amylase activity in finger millet seeds.
Figure 1: Malting process (Experiment 1) (Baik & Ulrich, 2014).
Methodology cont’d

• **Experiment 2**: Radicle growths were monitored with measuring ruler.

• **Experiment 3**: The method described by Asante *et al.*, (2013) was followed with slight modification to determine amylase activity using DNSA reagent.

Amylase activity (U) was calculated using this formula:

$$\text{Activities} \left( \frac{U}{\text{ml}} \right) = \left( \frac{\text{mg in terms of glucose}}{\text{ml}} \times 10^3 \right) \times \frac{\text{Molecular weight of glucose} \times \text{Time (min)}}{2}$$
Statistical Analysis

• The experiments were triplicated and data expressed as mean ± standard deviation. One-way analysis of variance (ANOVA) of the data was determined using Origin Pro 8.5. The significant differences were considered at 0.05.
Results

Figure 2: Effect of seed incubation period on radicle growth. Data expressed as mean ± SD.
Figure 3: The main effect of seed incubation temperature on radicle growth. Data expressed as mean ± SD.
**Figure 4**: Effect of seed incubation temperature on alpha-amylase activity. Data expressed as mean ± SD.
Figure 5: The effect of incubation period on alpha-amylase activity. Data expressed as mean ± SD.
Figure 6: Main effect of kilning temperatures on alpha-amylase activity in seeds incubated at 25 °C respectively. Data expressed as mean ± SD.
Table 1: Influence of incubation temperatures, incubation period and kilning temperatures on alpha amylase activity.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Err.</th>
<th>P &gt;</th>
<th>Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incubation period</td>
<td>0.0193264</td>
<td>0.003685</td>
<td>0.0</td>
<td>0.117517, 0.269011</td>
</tr>
<tr>
<td>Incubation temperatures</td>
<td>-0.025</td>
<td>0.0153184</td>
<td>0.0115</td>
<td>-0.0564875, 0.0064875</td>
</tr>
<tr>
<td>Kilning Temperatures</td>
<td>-0.064133</td>
<td>0.0250149</td>
<td>0.016</td>
<td>-0.1155522, -0.0127144</td>
</tr>
<tr>
<td>Constant</td>
<td>3.622833</td>
<td>0.9960182</td>
<td>0.001</td>
<td>1.568087, 5.67758</td>
</tr>
</tbody>
</table>

Number of observations = 30
F (3, 26) = 12.25
Prob > F = 0.0000
R-squared = 0.5856
Adj R-squared = 0.5378
Root MSE = 0.68506
The daily increase in α-amylase indicated breakdown of starch to dextrin’s during the malting process. This will in turn be useful for producing beverages with low viscosity with certain increase in solid content. This will result to a beverage with higher nutrient density than beer or beverages from un-malted finger millet (Ayenor and Ochoo, 2017; Obadina et al. 2013).

Furthermore, the disparity of alpha amylase activity between the seeds incubated at 25 °C (kilned at 30 °C) and malts kilned at 40 °C showed that kilning temperature influenced enzymatic activity in the incubated seeds at different temperatures. This depicted a positive correlation between incubation and kilning temperatures as well as amylase activity (Inyang and Zakarim 2008; Marchylo et al. 2004).
Conclusion

• Malting enhances the overall quality of finger millet, thus makes it suitable for production of malted-based foods and value-added products such as: probiotic beverage, beer, amylase rich foods, low dietary bulk weaning and supplementary foods.

• Incubation at 25 °C is optimal for maximum amylase activity in finger millet malt. Therefore, to promote good health and improve the utilization of finger millet, malting of finger millet at 25 °C for 72 h with kilning at 30 °C could be considered as the best malting parameters in the production of food and beer in the brewing industry because of its positive effects on the quality of finger millet malt.
Recommendation

• For future study, fermentation of finger millet malt produced at incubation temperature and time of 25 °C and 72 h respectively is recommended for production of beer and probiotic beverages.

• Also, the effects of malting on proximate, chemical and organoleptic properties of finger millet malt will be investigated.
Acknowledgements

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References


Thank you