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Evaluation of cooking time and organoleptic traits of improved Dolichos (*Lablab purpureus* (L.) sweet) genotypes

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In Lablab bean, cooking time and organoleptic qualities are major factors that influence its adoption and consumption. Its production in Kenya has been constrained by low yielding varieties, pests, poor agronomy and varieties with non-preferred taste and flavor. This study was initiated to evaluate cooking time and organoleptic traits of six Dolichos genotypes, (G2, B1, M5, LG1, W7 and G2), that had been bred at the University of Eldoret and two checks (Local Variety and DL1002). Cooking time and organoleptic studies were carried out on-farm in Meru County, Ruiri sub location using an organized farmer group (Ruiri farmers group) that comprised of ten panelists (seven women and three men). There was a high significant difference (P ≤ 0.001) among the six improved genotypes and the two checks in terms of cooking time and sensory attributes evaluated. Cooking time ranged from 87 to 159 min, with genotype M5 taking the shortest time (87 min) and local variety taking the longest time (159 min) to cook, respectively. In overall acceptability, genotypes G2, G1, M5 and B1 were highly rated because of their short cooking time and good organoleptic attributes. High variability among the genotypes evaluated could be exploited even further in breeding programs to produce genotypes that take even less time to cook and with even better organoleptic characters for easy adoption by farmers.

Key words: Lablab *(Lablab purpureus)*, cooking time, organoleptic traits.

INTRODUCTION

Dolichos (*Lablab purpureus* (*L.*) Sweet) (2n = 22) is a grain legume, adapted to most tropical environments: a wide range of rainfall, temperature and altitudes (Ravinaik et al., 2015; Rai, 2010). Across Africa subsistence farmers grow it for human consumption for vegetable (flowers, immature pods and mature grains) (Ngure et al., 2021; Uday et al., 2017), green manure, cover crop and concentrate feed for livestock (Hassan and Joshi, 2019; Maass et al., 2010).

Changes in climatic conditions have necessitated a worldwide interest in searching for new and potential uses of unconventional legumes. Pengelly and Maass (2001) concluded that because of its already well-established uses as a pulse, vegetable and forage, lablab is a priority genus in developing multi-purpose legumes in both commercial and small holder farming systems in the

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tropics. Cooking time and sensory quality are two important traits when selecting dry bean varieties for consumption but have largely been overlooked by breeders in favor of yield and other traits (Bassett et al., 2017). The cooking of most legumes involves several processes to render them palatable, digestible, and accessible for nutrient availability (Bergeson et al., 2016). As a result, cookability and organoleptic traits of beans are important attributes that affect the performance, selection and acceptance of bean varieties developed by breeders (Shivachi et al., 2012). Like other legumes, Lablab seeds contain anti-nutritional factors; trypsin and chymotrypsin inhibitors, tannins, phytohemagglutinins (lectins), lathyrogens, cyanogenic glycosides and goitrogenic factors, saponins and alkaloids (Wanjekeche et al., 2003; Vijayakumari et al., 1998). These anti-nutritional factors limit the usage of the legume, unless they are eliminated through processing e.g. by pre-soaking and subsequent discarding of the liquid and/or by heat treatment at relatively elevated temperatures (Wanjekeche et al., 2003). Prolonged cooking has a negative impact on beans; reducing their nutritive value especially vitamins and certain amino acids therefore results to the underutilization of the bean (Urga and Fufa, 2009).

Sensory factors are a major determinant of the consumers' subsequent purchasing behavior (Mkanda et al., 2007). Some of the most important characteristics considered in selecting dry bean varieties for production and consumption are fast food cooking and good flavor quality traits (Shivachi et al., 2012). In India for example, lablab is valued for its nutritional and sensory attributes (Venkatachalam et al., 2007). Cookability and organoleptic qualities are important attributes affecting performance, selection and acceptance of bean varieties developed by breeders (Shivachi et al., 2012). According to Coelho et al. (2009), prolonged cooking has been listed as one of the major factors responsible for underutilization of beans in many diets. Therefore, the improvement of locally adapted varieties is vital (Nene, 2006). This will minimize nutrient loss, reduce expenditure on fuel and shorten cooking time as well as help to fight food insecurity if successfully integrated in the farming system. Previous studies have shown that cooking time is an important trait in breeding of common beans especially where 96% of the beans consumed are prepared at household level (Shivachi et al., 2012; Jacinto-Hernandez et al., 2003).

Apart from cooking time, sensory characteristics such as appearance, texture and taste contribute to consumers' choice of a particular bean variety (Mkanda, 2007; Sanzi and Attienza, 1999). Descriptive sensory evaluation identifies, describes, and quantifies sensory attributes of a food material or product using human subjects. Sensory attributes that influence acceptance of cooked beans are visual appearance, texture and flavour-taste and aroma (Mkanda et al., 2007) as they contribute to consumers' like or dislike of certain bean varieties. Consumer sensory evaluation is a process of evaluating opinion of a particular product in terms of specific sensory attributes. An example of a participatory farmer evaluation form used in this study is as described in Supplementary Table 1 where farmers were expected to fill the form after examining each genotype.

Appearance: It is most important to consumers since they have certain expectations on how food should look like (Parker, 2002). It is divided into color and geometric (shape and size) attributes.

Texture: This is a quality felt with fingers, tongue and teeth. According to Mkanda et al. (2007), fast cooking beans have soft texture that is preferred by most consumers.

Flavor: It comprises of odor and taste. It is defined as a perceived attribute resulting from integrated responses to a complex mixture of stimuli on several senses, smell, taste, touch sigh and even hearing (reference?). Flavor, like appearance and texture, is a quality factor that influences the decision to purchase and consume a food product.

Over the years, farmers in Kenya preferred other legumes over lablab bean because of the bitter taste (Wanjekeche et al., 2000). Prolonged cooking time also increases the cost of utilizing the bean due to increase in amount of fuel needed (Shivachi et al., 2012). Odor of the lablab was also reported to affect acceptance (Kim and Chung, 2008). Similarly, a study on common bean reported that bitter taste contributes to consumers' dislike of some bean varieties (Mkanda et al., 2007). Studies are being conducted to improve Dolichos production in Kenya with a primary aim of identifying and evaluating various genotypes to come up with stable and well adapted cultivars for release and possible commercialization. Therefore, there is a need to carry out cooking time and organoleptic studies on improved lablab genotypes by the breeder, with the aid of the consumers/farmers, to ascertain whether he or she has achieved this objective. At the University of Eldoret Biotechnology Department, a breeding program was initiated to breed for the improvement of sensory and organoleptic traits (cooking time and taste) as well as high yielding *Lablab* varieties. Therefore, the objective of this study was to evaluate the diversity of the six improved Dolichos genotypes bred at University of Eldoret based on cooking time and sensory attributes.

MATERIALS AND METHODS

Genetic material

The genotypes used in the current study comprised of 6 lines that had been bred at University of Eldoret (W7, M5, B1, G1, G2 and LG1) to improve their yield, cooking time and taste and two commercial checks (DL1002 and a local land race (Local variety) collected from farmers' field in Meru county, Ruiri Village). The

Table 1. Description of the genotypes used in the study.

Entry	Genotype code	Seed color
1	LG1	Black
2	G2	Black
3	W7	Black
4	M5	Brown
5	G1	Black
6	B1	Dotted (Brown with black dots)
7	Local variety	Black
8	DL1002	Black

genotypes were selected based on yield, adaptability and ability to withstand pests and other diseases. The genotypes are as described in Table 1.

Study site

Cooking time and organoleptic studies were carried out on-farm in Meru County, Ruiri sub location using an organized farmers group (Ruiri farmers self-help group). This study site was selected because of the popularity of the crop in the region as well as the familiarity of the crop by the farmer group as Dolichos is part of their stable diet.

Experimental design and statistical analysis

In cooking time, cooking of the 8 genotypes was done to ascertain the cooking time of each genotype at a farm in Ruiri-Meru County in a Completely randomized design (CRD) with three tasting replicates. Organoleptic evaluation was also laid in a CRD where the coded samples were presented to the panel at random for evaluation. The taste panel consisted of 7 women and 3 men from the Ruiri farmers group in Meru County. Female formed the majority of the panelists' since they are usually involved in preparation of meals therefore are likely to be more sensitive to taste than men (Shivachi et al., 2012; Kigel, 1999). The data was subjected to statistical analysis using Genstat discovery 13th edition. Means were separated using Duncan's Multiple Range Test (DMRT) of the same software.

Cooking time

Saucepans 'sufurias' used in the experiment were of same size and were made of stainless steel with tight fitting lids. Heating system used was charcoal since it was the most convenient in the study site. A quarter (¼) Kgs of each genotype was weighed, cleaned and cooked in accordance with Gisslen (2007) protocol with few modifications in terms of the quantity of water, source of heat and quantity of grains used. All the eight genotypes were coded differently to avoid bias when scoring.

After the eight "jiko's" lit, one and a half liters of water was put in each saucepan and let to boil. Water from all the source pans was let to boil before the seeds were put in to take care of errors that may have arisen due to the different intensities from the source of heat. Once the water in all the source pans was boiled, each ¼ kg seed genotype was poured into the separate saucepans simultaneously and then covered with tight fitting lids of the same size and then timing started. During the cooking process, the samples remained covered with water and it was added intermittently as its level dropped until the grains were fully cooked to acceptable tenderness. Tenderness was determined using the method of Njoku and Ofuya (1989), by subjectively pressing the beans in between fingers until no hard material was found as traditionally done. One person was allowed to determine the tenderness of all the genotypes; this was to take care of errors that could have arisen due to various people having different textures on their fingertips as well as different strengths when pressing the beans. Samples were allowed to cook for the first sixty minutes. For the next thirty minutes sampling was done at an interval of ten minutes and at intervals of five minutes for the rest of the cooking time. The cooking time was recorded for the genotypes that had cooked to the required tenderness. This was calculated from the initiation of cooking until 80% of the grains were cooked. Three sample replicates of each genotype were cooked separately and each cooking time recorded. An average from the three readings was then calculated and recorded as the cooking time for each genotype.

Organoleptic tests

Before sensory evaluations were made, a panel of reviewers was trained to rate different attributes using the determined hedonic scales (Supplementary Table 1). After cooking the seeds to the acceptable tenderness, organoleptic tests were done. The panelists were trained on what they were expected to do and how they were to carry out the scoring. The attributes evaluated included: appearance, texture, taste, and overall acceptability. Appearance (size and shape) was rated by sight, texture by rubbing gently between the thumb and index fingers of the hand and in the mouth and taste in the mouth. Evaluations were done through quantitative descriptive analysis. The panelist indicated the intensity of the specified characteristic (Appearance, Taste and Texture), by checking an appropriate category and ordering them using five descriptive terms (1= Very bad, 2= Bad, 3= Fair, 4= Good and 5= Very good) (Supplementary Table 1). The cooked samples used for tasting were code blinded from the panelist and served on ten plates then given to the taste panel for evaluation. One sample was evaluated at a time by all panelists. They rated each sample depending on the intensity of the sensation perceived. After testing and scoring one sample, the panelists were given water for rinsing the plate and their mouths before proceeding to the next sample.

RESULTS

Cooking time

There was a significant difference in cooking time ($P \leq 0.001$) among the genotypes evaluated (Table 2). Cooking time for the genotypes ranged from 87 to 159 min with genotypes M5 taking the shortest time to cook

Table 2. Mean cooking time.

Genotype	Cooking time
W7	131.67^{e}
G2	117.0^{d}
M5	87.67^{a}
B1	99.33^{b}
LG1	107.67^{c}
G1	121.0^{d}
Local Variety	159.33^{g}
DL1002	154.0^{f}
Grand mean	122.21
MS$_{(Genotype)}$	1900.7***
MS$_{(error)}$	2.6
SD	256.64
CV (%)	2.1

Table 3. Means for organoleptic traits.

Entry	Genotype	Appearance	Taste	Texture	Acceptability
1	**W7**	4^{cd}	3.4^{bc}	3.8^{bc}	3.8^{bc}
2	**G2**	4.4^{de}	4.1^{de}	4.3^{cd}	4.3^{de}
3	**M5**	3.4^{ab}	4.6^{e}	4^{bc}	4^{cd}
4	**B1**	3.8^{bc}	4^{cde}	4.3^{cd}	4^{cd}
5	**LG1**	3.3^{ab}	3.6^{bcd}	3.5^{b}	3.5^{b}
6	**G1**	4.9^{e}	4^{cde}	4.8^{d}	4.5^{e}
7	**Local Variety**	3.1^{a}	2.6^{a}	2.9^{a}	2.9^{a}
8	**DL1002**	4^{cd}	3.3^{ab}	3.9^{bc}	3.7^{bc}
	Grand mean	3.8	3.7	3	3.8
	MS$_{(Genotype)}$	2.9***	3.1***	2.5***	2.1***
	MS$_{(error)}$	0.5	0.7	0.6	0.4
	CV (%)	13.6	18.5	15.7	10.9

N/B*** = Significant at P ≤ 0.001. Means followed by the same letter are not significantly different, according to Duncan's Multiple Range Test (DMRT).

while the local variety taking the longest time to cook. Five out of eight genotypes had cooking time lower than the general mean (122.21 min), all of them being the new varieties. Genotype M5 took an average of 87 min to cook which is less than 1 h and 30 min, genotypes B1, LG1, G2 and G1 took an average of 99, 107, 117 and 121 min to cook respectively, which is within 2 h. However, genotypes W7, DL1002 and Local variety took an average of 131, 154 and 159.33 min to cook which is more than 2 h and above the average mean.

Organoleptic traits

The results obtained from the organoleptic traits, that is, appearance, taste, texture and acceptability, evaluated were highly significant, due to the differences in their means at P ≤ 0.001 (Table 3). The local variety was ranked lowest in all the traits evaluated whereas genotype G2 and G1 were ranked highly in all the traits evaluated. Despite genotype W7 being ranked highly in appearance, it was ranked average in terms of acceptability. There was a deviation from the expected, that brown genotypes would be ranked highly for appearance, where some brown genotypes B1 and M5 were ranked poorly and given low scores for appearance, 3.75 and 3.38, respectively. Genotypes G1, G2, M5 and B1 received the highest overall acceptability scores of 4.54, 4.25, 4.0 and 4.0, respectively. This is due to the fact that they were highly scored in all of the traits evaluated except for genotype M5 and B1 which received low scores of 3.37 and 3.75 for appearance. This high level of significance in the organoleptic traits evaluated (P ≤ 0.001) depicts the importance of organoleptic evaluation and thus should also be incorporated in other breeding programs as an important aspect in breeding and selection.

DISCUSSION

The reduction in cooking time has important implications for fuel wood requirements as majority of households rely on charcoal for cooking (Bergeson et al., 2016). There was a notable significant difference between the new genotypes and the checks (a local variety and DL1002) with the new genotypes taking a shorter cooking time as indicated by the results in Table 2. There was significant variation in cooking time among the eight genotypes ranging from 87 to 159 min. The cooking times recorded in this study are lower than findings form, Shivachi et al. (2012) who reported cooking time of thirteen genotypes to be between 70-197 min. Bassett et al. (2017) reported cooking times of 389 dry bean genotypes ranged from 16.7 to 68.9 min. Comparatively, the two checks (DL1002 and Local variety) took relatively long time to cook than the new improved genotypes. This was expected since the new genotypes had been bred to improve on their cooking time as well as organoleptic traits. The shortest cooking time was 87 min recorded by M5 which is a brown seeded genotype followed by B1, that recorded 99 min, and which is also brown seeded but has black dots and the longest cooking time of 159 min was recorded by Local variety which is black seeded, and a common land race grown by farmers in Ruiri-Meru.

Variation in cooking time is caused by many factors among them: genetic makeup of the genotypes, energy source used, type of water used, size and age of the beans among others (Shivachi et al., 2012). However, because most of these factors that is, heat supply, water type, source of heat, age and size of bean, were kept constant during the experimentation, it can therefore be concluded that the difference in cooking time among the genotypes could be attributed to their genetic makeup (Bitjoka, 2008; David and Konesh, 2004; Ngwira and Mwangwela, 2001). The black seeded genotypes took longer to cook than the brown seeded genotypes, this finding also concurred with findings from Shivachi et al. (2012). This result could be attributed to high anti nutrient levels in their seed coats.

Maass and Usongo (2007) and Pengelly and Maass (2001) related lablab color to anti nutrient levels and found dark seeded types to contain high amounts of these substances than white or cream seeded types. A large amount of heat is thus required to eliminate these compounds resulting in prolonged cooking of these genotypes (Shivachi et al., 2012). Adeboye (2006) and Fasoyiro et al. (2005) also concluded that dark seeded pigeon pea and mucuna varieties took longer time to cook owing to large amounts of anti-nutritional factors contained in their seed. From the organoleptic results gotten we can also conclude that anti nutritional factors are responsible for bitter taste, that is, dark/black genotypes received low scores for the taste attributes. These genotypes are thus associated with extended cooking time to eliminate their bitter taste. Osman (2007) also made similar observations.

All organoleptic traits evaluated were highly significant ($P \leq 0.001$) for the four traits evaluated. From the findings, it was clear that the sensory panelist had clear preference when it came to the specific genotypes. A major finding from the panelist was that the quality traits of appearance, taste and texture are fundamental and greatly affect consumers' preference for particular lablab genotypes. With regards to appearance, genotype G2 was rated highest and Local variety was lowest. This may be attributed to the fact that G2 has uniform, round and well filled seeds as opposed to the local variety that has flat and the seeds are not well filled and thus not appealing. In terms of taste, genotype M5 was rated highest while the local variety was rated lowest (Table 3). This could be attributed to the anti-nutritional content of the genotypes, since M5 is brown seeded as opposed to the Local variety which black seeded. These results were similar to Shivachi et al. (2012) and Mkanda et al. (2007) who reported that black seeded genotypes were more bitter than the brown seeded genotypes. In a study by Kimani et al. (2017), sensory tests showed significant differences for the bitter taste ($P \leq 0.05$).

In pulse, white or cream genotypes are highly preferred to dark once because the latter, contain relatively high amounts of anti-nutritional factors giving them a bitter taste (Shivachi et al., 2012). In terms of texture, B1 was rated highest while Local variety was rated lowest. Genotype G1 was rated the highest and local variety lowest in terms of the overall acceptability, Table 3. This could be attributed to the fact that despite the seeds being black in color, they are large, smooth, uniform size and well filled, thus the farmer preference. Local variety was ranked least in nearly all the traits that were evaluated. This was a clear indication that most of the genotypes that are grown by farmers need to be improved.

Organoleptic traits, that is, appearance, texture and taste, affect the general acceptance of the lablab genotypes and that farmers adopt genotypes based on all these factors that is, desirable agronomic attributes like growth habit, yield and adaptation. Similar observations have also been sighted by Kankwatsa and Muzira (2018) and Kinyua et al. (2008). From these findings therefore, new genotypes especially beans need to be subjected to both cooking time and organoleptic trait evaluations to ascertain their overall acceptability by the farmers who are the end users of these varieties.

CONCLUSION AND RECOMMENDATION

Results from cooking time showed that improved genotypes took less time to cook than the two checks, therefore the overall objective of this study was achieved. The organoleptic study showed that sensory traits of appearance, texture and taste greatly affect consumers' choice and thus influencing the adaptability of bean varieties. In this study, anti-nutritional factors were neither qualified nor quantified, and thus need further investigation to ascertain their contribution to cooking time.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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Supplementary Table 1. Participatory farmer evaluation form.

Genotype code ……………………….
Evaluator's name ……………………………………………… Date……………………

Trait	Score/Rank
Inavyoonekana/ Appearance	
Cooking time	
Ladha/ Taste	
Texture	
Kukubalika/ Overall adaptability	

KEY

1- Mbaya sana	1- Very bad
2- Mbaya	2- Bad
3- Inaridhisha	3- Fair
4- Nzuri	4-Good
5- Nzuri sana	5- Very good

Maoni/ comments

………
………