Quality Evalution of Potato Clones as Processed Material Cultivated in Lembang

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Abstract. Potatoes are widely grown in the temperate as well as tropical zones and are the fourth largest staple crop in the world after maize, wheat and rice. The study aimed to evaluate the quality of several potato clones as raw material on potato based products (chips and boiled). The study was conducted at Indonesian Vegetable Research Institute, Lembang about 1200 m asl height, in 2016. The design used was a randomized complete block design with three replications. The samples tested were 5 clones selection (clones number 1,2,3,4,10). In this study, variety Granola (Clone number 6) and Atlantic (Clone number 7) were used as a susceptible control, meanwhile the Katahdin (Clone number 8) and SP 951 (Clone number 9) were used as the resistant control. Chemical properties tested were starch, reduction sugar, water content, specific gravity, and Total Soluble Solute (TSS). The organoleptic assessment method used was hedonic test with scale of 1-5 (very like until very dislike) which had been done by 15 untrained panelists. Data was statisticaly analized by Duncan's test (5%). Clone 1 and 2 were preferred by panelist as raw material for potato chips, which got score of 'very like' until 'like' for color, size, taste, and texture parameters. Although there was no significant difference on color and size parameters for all samples of that boiled potato there, however, clone no 8 can be considered as the most favourite based on taste and texture parameters.

1. Introduction

Potatoes are the third largest food crop worldwide following rice and wheat, which are valued globally for their ease of cultivation, preparation and as a readily assimilated source of carbohydrate (CHO) energy [1]. Nutritionally, the role of carbohydrate metabolism is critical to the regulation of our energy intake and maintenance of body weight. Crop genetic resources are very important for crop-based industry. Heritage potatoes have a great diversity of skin and flesh color combined with unusual tuber shapes, textures and flavours. Starch granule sizes have been known to influence the digestibility and glycemic index of potato starch [2,3]. Bruise-free, high specific-gravity tubers are desirable, and the processing industry often pays incentives for each of those quality goals.

The physical maturity of tubers refers to skin set and the development of a mature periderm. Tubers that are physically immature have poor skin set, and a skin that is permeable to water and susceptible to skinning. Physiological maturity refers to the dry matter content and is achieved when tuber dry matter reach a maximum. Chemical maturity is critical for the processing industry. Maturity can be

manipulated by various growth factors, such as seed treatment, planting date, nitrogen fertilizer management and harvest strategy [4].

Textural characteristics have been found to affect flavor perception in a wide variety of foods and beverages. The influence of textural characteristics on flavor perception has been shown to be dependent on the oral processing exhibited when consuming the food [5]. Maillard reaction between sugars and amino acids is considered to be the main mechanism for acrylamide formation, with asparagine and reducing sugars as the major reactants present in foods [6]. Since potatoes are high in both asparagine and reducing sugars such as glucose and fructose, frying potato chips generates optimum conditions for acrylamide formation [7]. Acrylamide is a chemical compound naturally formed during processes such as frying, roasting and baking in a wide variety of foods including French fries, potato chips, cereal, bread and coffee [8]. It has been reported to be a human neurotoxin, a rodent carcinogen and robable carcinogen to humans [9].

2. Materials and Methods

The experimental design used in this study was a randomized complete block design with three replications. The materials tested were 5 clones selection (clone number 1,2,3,4, and 10).Varieties for comparison are Granola, Atlantic, Katahdin, and SP 951 as control. Plant sources of inoculum were planted at least three rows around the field trial. Planting system was arranged in single row, with a spacing of 30 cm x 70 cm. Horse manure in dosage 30 ton/ha was applied a week before planting. Synthetic fertilizer (1000 kg/ha NPK with ratio 16:16:16, 100 kg urea/Ha, and 500 Kg Za /Ha) was applied twice on planting and 30 day after planting (DAP). Plant maintenance such as weeding was done for 2-3 times on 14, 45, and 75 DAP. Other maintenance, including insecticide and fungicide applications were applied at 14, 21, 28, and 35 DAP, with contact and systemic fungicides alternately. Chemical characteristic testing are starch, reduction sugar, water content, specific gravity, and Total Soluble Solute (TSS). Organoleptic tests were conducted by 15 untrained panelists who gave score of 1-5 (‘strongly like’ until ‘strongly dislike’). Data was statisticaly analized followed by Duncan’s test (5%).

3. Results and Discussion

Chemical characteristics of potatoes which were analyzed inthis study including starch content, reduction sugar, water content, specific gravity and total soluble solid (TSS, is shown in table 1. Since starch comprises the largest part of dry matter, it has direct influence on technological quality, especially with regard to the texture of the processed products [10]. Starch content showed a positive correlation with specific gravity, texture, pulp pH, and soluble solid, and was negatively correlated with reducing sugars[11]. High sugar accumulation and low starch content are unwanted since it will affect chips appearance and will not be preferred by consumers. Previous studies [12,13] verified a variation from 0.5 to 2.0% in reducing sugars contents in potato tubers. Tubers with reducinmg sugar contents higher than 2% are unacceptable for frying[14]. Based on our analysis, the starch content of selected clones values were ranging from 5.86%-10.61%. The highest starch content found in clone no.7 (control) and no 8. Meanwhile, the reducing sugar content of all clones were not significantly different and showed value below 2%. Among all selected clones, the control showed the lowest value, and clone no 1 showed the highest value.

Table 1. Chemical Characteristics of Potato Clones.

Clone	Starch (%)	Reduction sugar (%)	Water content(%)	Specific gravity (gcm^{-3})	TSS (^{o} Brix)
1	6.88^{cd}	0.04	85.27^{b}	1.04	3.33^{ab}
2	7.25^{cd}	0.03	86.06^{b}	1.05	3.67^{a}
3	7.32^{cd}	0.03	89.02^{a}	1.03	2.67^{b}
4	7.19^{cd}	0.03	86.49^{ab}	1.05	3.40^{ab}
5	7.08^{cd}	0.03	86.82^{ab}	1.04	3.27^{ab}
6	7.20^{cd}	0.03	87.22^{ab}	1.05	3.47^{ab}
7	10.61^{a}	0.02	81.25^{c}	1.06	4.00^{a}
8	9.45^{ab}	0.03	84.93^{b}	1.05	3.60^{ab}
9	7.98^{bc}	0.03	85.55^{b}	1.03	3.47^{ab}
10	5.86^{d}	0.03	86.54^{ab}	1.02	3.13^{ab}

* The number followed by the same character on the same column is not significantly different, based on Duncan Test (5%).

Water content of selected clones varied from 81.25 to 89.02%. Clone no 7 (control) showed the lowest water content (81.25%), meanwhile the highest were found in clone no 3 (89.03%). Early maturing potatoes, which can be used such as for boiling, baking, frying, roasting or mashing usually have lower dry matter, higher water content and different starch structure [15].The specific gravity is important quality attributes because it can indirectly provide a dry matter content estimation, and is also related to industrial yield, oil absorption during frying, and final product quality. Studies showed that minimal value of specific gravity requirement for potato chips in national industry is 1.067[16]. Based on this research analysis, the specific gravity of the clones were not significantly different and ranging between 1.02 to 1.06. Clone no 7 (control) showed the highest value, which was 1.06, and followed by clone no 2, 4, and 8 which were 1.05. In this research, lowest TSS were found in clone 3 which was 2,67^{o} Brix while the highest was found in clone no 7, 4,00 ^{o} Brix. Clones no 7 used in this study is Atlantic cultivar which had been used as a control for processed potatoes, especially potato chips.

Figure 1. Potato Chips.

The results of organoleptic test on potato chips (table 2) showed that panelists gave score 'very like' until 'like' on color parameter of clone no 1, 2,4, 8, and 9. Meanwhile, on size parameter, panelist gave score 'like' for all clones except clone no 10. Clone no 1 had taste and texture that preferred by panelist who gave score 'very like' and showed to be significantly different with clone no 10.

Table 2. Organoleptic Test on Potato Chips

Clones	Color	Size	Taste	Texture
1	1.47^{d}	1.93^{b}	1.87^{c}	1.67^{d}
2	2.13^{cd}	2.20^{b}	2.53^{abc}	1.93^{cd}
3	3.67^{a}	2.80^{ab}	3.07^{ab}	2.47^{cd}
4	2.40^{bcd}	2.27^{ab}	2.27^{bc}	2.27^{cd}
5	2.67^{abc}	2.13^{b}	2.47^{abc}	2.93^{bc}
6	3.33^{ab}	2.87^{ab}	2.67^{abc}	3.07^{bc}
7	2.87^{abc}	2.40^{ab}	3.07^{ab}	3.73^{ac}
8	2.53^{bcd}	2.20^{b}	2.40^{abc}	3.00^{bc}
9	2.00^{cd}	2.13^{b}	2.13^{bc}	2.13^{cb}
10	3.33^{ab}	3.27^{a}	3.53^{a}	4.47^{a}

* 1= strongly like; 5= strongly dislike
** The number followed by the same character on the same column is not significantly different

Textural characteristics can influence flavor perception in liquid and soft foods to crisp/brittle foods. In addition, the effect of crispness level on flavor perception varies by flavor type, age group, and mastication pattern [17]. The colorless potato is more preferable as it also corresponds to the acrylamide contecnt. Acrylamide is correlated negatively with the Agtron chip color score. Agtron chip color represents a a score system in which 0 is equal to black and 90 is equal to white. Agton Score of 50 or greater is considered as color that is commercially acceptable. Potatoes that rich in reducing sugars will turn dark rapidly and produce high levels of acrylamide. In this study, the reducing sugar of two clones selected were lower (0,029 and 0,023) than that the reducing sugar content of the other potato clones which had dark color [18].

The dry matter from untransformed potato which contains high amylose during the various storage periods whereas significantly. Pyruvate decarboxylase in transgenic Snowden had increasing resistant starch and higher dry matter contents of phosphorus, and had decreasing acrylamide levels in potato chips made from these potatoes [19]. Recently, there has been increasing concern regarding the production of acrylamide during the frying process due to its potential carcinogenic properties. Acrylamide has been shown to be mainly formed in food by Maillard browning reactions of reducing sugars with asparagine at temperature above 12^{o}C.

Table 3. Organoleptic Test on Boiled Potato

Clones	Color	Size	Taste	Texture
1	2.00 a	2.00 a	2.20 ab	2.27 b
2	2.60 a	2.60 a	2.33 ab	2.13 b
3	2.40 a	2.40 a	2.40 ab	3.40 ab
4	2.93 a	2.93 a	2.67 ab	2.87 ab
5	2.67 a	2.67 a	2.60 ab	2.80 ab
6	2.00 a	2.00 a	2.27 ab	2.87 ab
7	3.07 a	3.07 a	2.53 ab	3.80 a
8	2.87 a	2.87 a	2.07 b	2.27 b
9	2.07 a	2.07 a	2.20 ab	2.40 b
10	2.93 a	2.93 a	3.07 a	3.00 ab

* 1= strongly like; 5= strongly dislike
** The number followed by the same character on the same column is not significantly different

Figure 2. Boiled potato.

Organoleptic test on boiled potato clones had also been conducted to measure the clones as processed material (table 3). In general, clone no 10 were less accepted by panelists. Although, there was no significant difference between all clones for color and size parameters (table 3), however, a significant difference for taste and texture parameter was observed.

Textural characteristics have been found to affect flavor perception in a wide variety of foods and beverages. The influence of textural characteristics on flavor perception has been shown to be dependent on the oral processing exhibited when consuming the food. Changes in textural characteristics lead to variations in mastication that may change the physical properties of the food bolus altering how aromatic compounds are released from the food matrix [20]. The majority of work on texture–flavor interactions has been performed with a focus on rheological properties such as flow and deformation in liquid and soft food, however, crisp or brittle foods have received little attention. In the tasting parameter, panelists gave the highest score for clone no 8 which was

significantly different than that clone no 10. Meanwhile, on texture parameter, panellists were preferred to clones no 1, 2, 8, and 9 which were significantly different to other clones.

4. Conclusion

Clone 1 and clone 2 were preferred by panelists as raw material for potato chips, which got score of 'very like' to 'like' for color, size, taste, and texture parameter. Although there was no significant difference on color and size parameters for all samples of that boiled potato there, however, clone no 8 can be considered as the most favourite based on taste and texture parameters.

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