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# Evaluation of shelf life of various carrot genotypes planted on three different highlands

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**Abstract.** Carrot contains quite high nutrition, especially carotenoids, which function as antioxidants. This research aimed to evaluate the shelf life of various candidates among carrot genotypes that will be released as varieties. The research was applied toward those candidates which had been planted on three different locations were Cipanas, Garut, and Lembang. The evaluation was run at Postharvest Laboratory of Indonesian Vegetable Research Institute (IVEGRI), Lembang from March until July 2016. Shelf life was tested throughout quantitative evaluation using a hedonic test which admitted 15 untrained panelists and quantitative evaluation using measurement equipment. Parameters observed on carrot sensorial properties were colors and textures. Quantitative evaluation (method using equipment) applied for texture and weight loss parameters. Subsequently, correlation analysis was used to find out the relation between variable x (qualitative) and variable y (quantitative). Statistical analysis was run by using PKBT STAT. The result showed an interaction between genotypes and different planting locations toward carrot shelf life. Independently, planting locations showed a significant effect on carrot shelf life. Meanwhile, different genotypes showed a non-significant effect in carrot shelf life. All genotypes showed a non-significant difference in carrot shelf life. However, genotype F showed the longest shelf life 3three days, whereas genotype C showed the shortest shelf life two days at room temperature in Lembang.

## 1. Introduction

Carrot is a highly valued plant for the fruit and vegetable market, as it is a rich source of nutrients that are important to the human body. It is also valued because of the content of biologically active compounds. The roots of carrots are easy to store and provide the raw material for the production of dried carrot, juices, concentrates, frozen, and canned foods. Among the succulent vegetables, carrot rank third in world production. This because carrots not only are popular and inexpensive but also they are easily grown, have a long period harvest, ship well, and have a relatively long storage life at a low temperature. Carrot cultivars differ in nutritional value, and the quality of individual pieces may differ from the average, which can be troublesome for companies that process carrots. Carrots accumulate sugars as they mature in the field. A high sugar content improves eating quality, increases storage potential and maintains moisture in the roots during storage. At harvest, carrots must be firm and bright orange in colour, should have achieved sufficient size to fill in the tips, and should have a uniform taper from shoulder to tip. The concentration of bitter compounds in carrots depends on genotype, location, growing and storage conditions and preparation methods [1,2].

Some characteristic of the quality of agricultural products is measured from size, shape, color, texture, flavor, and nutritional content. The characteristics of quality could be tested by sensory test,



especially for color, flavour, and texture. Sensory quality of food was the hallmark characteristics of food that is raised by one or a combination of two or more properties that can be identified by using human senses. Sensory testing or recalled as organoleptic testing is a process of identification, scientific measurement, analysis, and interpretation attributes of the product through the five human senses. It could be qualitative or quantitative. As a hedonic scale can be used to know the difference, hence it is quite often used to assess similar organoleptic products [3].

The shelf life of food products can be regarded as the period of time during which a product could be stored until it becomes unacceptable from safety, nutritional, or sensory perspectives [4]. Shelf life estimation of food products and beverages has become increasingly important in recent years due to technological developments and the increase in consumer interest in eating fresh, safe and high-quality products. The shelf life of the majority of food products is determined by changes in their sensory characteristics [5]. The shelf life of most food products is limited by changes in their sensory characteristics. In this context, sensory shelf life estimation of foods has become an issue of continuous and extensive research on both the deteriorative mechanisms occurring in food systems and the development and application of methodologies for shelf life estimation. Shelf life is a function of time, environmental factors, and susceptibility of product to quality change [6]. Physical, chemical and biological changes that occur throughout the food chain generally lead to product deterioration and these changes might in time compromise nutritional, microbiological or sensory quality. In many products changes in sensory characteristics occur largely before any risk to consumers' health is reached [7].

Freshly harvested carrots must be sorted to remove defective roots; undersized, broken, diseased, green core, split/cracked and sunburnt carrots should also be discarded. Careful handling is necessary to avoid bruising and tip breakage during these grading steps. Freshness is a quality criterion of great importance to the consumer for the acceptance of fruit and vegetables. However, what the consumer perceives as fresh is not clear. Product characteristics measured by descriptive sensory and physicochemical analyses were related to consumer and expert panel (individual and consensus) ratings of freshness. It awakens certain expectations from consumers as it is a critical variable affecting food quality. Although freshness has been shown to be of great importance for consumer choice of fruit and vegetables [8], there is little published research on its perception by consumers. This research aimed to evaluate the shelf life of various candidates among carrot genotypes that will be released as varieties.

## 2. Materials and Methods

The research was applied toward eight genotypes which had been planted on three different locations were Cipanas, Garut, and Lembang. The evaluation was run at Postharvest Laboratory of Indonesian Vegetable Research Institute (IVEGRI), Lembang from March until July 2016. Physical characteristic testing is the length, diameter, and weight. Shelf life was tested throughout quantitative evaluation using a hedonic test which admitted 15 untrained panellists and quantitative evaluation using measurement equipment. Parameters observed on carrot sensorial properties e.g. colours and textures. Quantitative evaluation (method using equipment) applied for texture and weight loss parameters. Subsequently, correlation analysis was used to find out the relation between variable x (qualitative) and variable y (quantitative). Statistical analysis was run by using PKBT STAT and Tukey's Test at level 5%.

## 3. Results and Discussion

### 3.1. Physical characteristics of carrots planted in three locations

Table 1 showed that different locations gave a significant effect on root length parameter. Carrots planted on Garut have the longest roots, whereas Cipanas produced carrots with the shortest roots. Meanwhile, from a genetic point of view, genotype A featured the longest roots that significantly differs from B, C and D genotypes, whereas genotype C had the shortest roots. Data showed that variation in root size depends on the variety (genetic) difference. Root length ranged from 5 - 50 cm and root diameter ranged from 20-50 mm [9]. Table 2 showed that although planting locations and genotypes did not give significant effect independently on root diameter, they were found to be interactive with each

other. However, root diameter observed on Lembang had the largest size (20.43 mm), meanwhile, the smallest size observed on Cipanas. This research resulted in root diameter which ranged from 18.59 - 20.58 mm, which meet quality standard II based on SNI (Table 3).



**Figure 1.** Eight genotypes carrot

**Table 1.** The mean of root length (cm) of carrot planted on three locations

Genotype	Cipanas	Garut	Lembang	Means of Genotype
Genotype A	11.84	14.73	14.38	13.65a
Genotype B	10.76	12.22	11.82	11.60bc
Genotype C	8.89	11.13	10.2	10.07c
Genotype D	10.21	12.08	12.02	11.43bc
Genotype E	11.46	12.3	12.4	12.05ab
Genotype F	11.14	12.06	12.42	11.87abc
Genotype G	11.62	12.96	11.59	12.06ab
Genotype H	9.63	14.33	11.64	11.87abc
Means of Location	10.69 <sup>b</sup>	12.72 <sup>a</sup>	12.06 <sup>a</sup>	

CV= 12.21%. The number followed by the same character on the same column is not different significantly

The cultivar is one of the main factors that stand out in the characterization of the physicochemical composition of carrot. The postharvest conservation time is related to the differences in water loss that different cultivars present in relation to the surface volume of each cultivar [10]. Fruits and vegetables are notoriously variable, and the quality of individual pieces may differ from the average [11].

**Table 2.** The mean of root diameter (mm) of carrot planted on three locations

Genotype	Cipanas	Garut	Lembang	Means of Genotype
Genotype A	18.98 <sup>ab</sup>	19.16 <sup>a</sup>	18.77 <sup>b</sup>	18.97
Genotype B	18.27 <sup>b</sup>	19.02 <sup>a</sup>	18.49 <sup>b</sup>	18.59
Genotype C	16.58 <sup>b</sup>	20.97 <sup>a</sup>	20.58 <sup>ab</sup>	19.37
Genotype D	18.58 <sup>b</sup>	19.51 <sup>a</sup>	18.71 <sup>b</sup>	18.93
Genotype E	18.38 <sup>b</sup>	19.99 <sup>a</sup>	22.24 <sup>ab</sup>	20.2
Genotype F	18.21 <sup>b</sup>	19.70 <sup>a</sup>	23.02 <sup>a</sup>	20.31
Genotype G	22.72 <sup>a</sup>	17.95 <sup>a</sup>	21.09 <sup>ab</sup>	20.58
Genotype H	19.13 <sup>ab</sup>	18.12 <sup>a</sup>	20.58 <sup>ab</sup>	19.28
Means of Location	18.86	19.3	20.43	

CV = 9.05%. The number followed by the same character on the same column is not different significantly

Vegetables from organic farming are characterized by significant variation, particularly as regards shape. Tests conducted on carrots indicate that the system of cultivation can have a substantial impact on the accumulation of carotenoids and sugars in the roots. The roots of carrots from organic farming were characterized by a higher content of sugars,  $\beta$ -carotene, and lutein in comparison to conventional crops [12].

**Table 3.** Carrot Quality Standard based on Indonesia National Standard (SNI 01-3163-1992)

Characteristics	Standard		Testing Methods
	Quality I	Quality II	
Character stability within a variety	Uniform	Uniform	Sensorial test
Hardness	Hard	Hard	Sensorial test
Color	Normal	Normal	Sensorial test
Root surface	Coarse	Coarse	Sensorial test
Hardness (Ligneous/woody)	Not ligneous	Not ligneous	Sensorial test
Root defects, % (number of defects/maximum defects)	5	10	SP-SMP-310-1981
Decayed, % (weight/maximum weight)	2	2	
Diameter (mm)	31- 50	15-30	

Based on the average of the four seasonal collections, 24% of the total variation in carrot composition was found to be attributable to seasonal change, 46% to region, 24% to the farmer, and 6% to individual samples [13]. The research showed that genotypes did not give a significant effect on root diameter, meanwhile planting locations gave a significant effect on root weight. Carrots planted on Lembang yielded heaviest roots, whereas carrots planted on Cipanas had the lightest roots. Yield and nutrition content was mostly affected by genetics (varieties) and the environment. Environment aspects include humidity, temperature, lightning, soil type, fertilizer, and cultivation techniques.

**Table 4.** The mean of root weight (g) of carrot planted on three locations

Genotype	Cipanas	Garut	Lembang	Means of Genotype
Genotype A	35.3	57.6	57.43	50.11
Genotype B	32.41	52.99	49.99	45.13
Genotype C	21.02	53.14	53.08	42.41
Genotype D	30.21	50.13	51.01	43.78
Genotype E	35.35	44.38	62.78	47.5
Genotype F	30.94	63.85	63.81	52.87
Genotype G	43.84	49.01	53.46	48.77
Genotype H	29.4	60.27	52.19	47.29
Means of Location	32.31 <sup>b</sup>	53.92 <sup>a</sup>	55.47 <sup>a</sup>	

CV= 19.58%. The number followed by the same character on the same column is not different significantly

### 3.2. The shelf life of carrot planted on three locations

Statistical analysis showed an interaction between genotypes and location on carrot shelf life. Planting location gave a significant effect on shelf life, meanwhile, genotypes did not give a significant effect on shelf life. All given genotypes showed a non-significant difference on shelf life, however, it can be said that genotype F had the longest shelf life (3.02 days), whereas genotype C had the shortest shelf life (2.45 days).

**Table 5.** Shelf life (days) of carrot planted on three locations

Genotype	Cipanas	Garut	Lembang	Means of Genotype
Genotype A	3.17 <sup>a</sup>	3.39 <sup>a</sup>	2.04 <sup>ab</sup>	2.87
Genotype B	3.30 <sup>a</sup>	3.26 <sup>a</sup>	1.77 <sup>b</sup>	2.78
Genotype C	2.18 <sup>b</sup>	2.94 <sup>a</sup>	2.23 <sup>ab</sup>	2.45
Genotype D	2.56 <sup>ab</sup>	3.15 <sup>a</sup>	2.54 <sup>ab</sup>	2.75
Genotype E	3.12 <sup>ab</sup>	2.83 <sup>a</sup>	2.06 <sup>ab</sup>	2.67
Genotype F	2.77 <sup>ab</sup>	3.48 <sup>a</sup>	2.81 <sup>a</sup>	3.02
Genotype G	2.94 <sup>ab</sup>	3.10 <sup>a</sup>	2.29 <sup>ab</sup>	2.78
Genotype H	3.01 <sup>ab</sup>	3.08 <sup>a</sup>	2.25 <sup>ab</sup>	2.78
Means of Location	2.88 <sup>ab</sup>	3.15 <sup>a</sup>	2.25 <sup>b</sup>	

CV= 15.69%. The number followed by the same character on the same column is not different significantly

Freshness is a multidimensional attribute and its perception seems to be influenced by a number of sensory and non-sensory characteristic. Focusing exclusively on one group of characteristics, for instance, sensory characteristics will not result in a global view of consumer perception but present the advantage of giving a more detailed map of the underlying sensory attributes influencing freshness. For this purpose, collecting consumer ratings of freshness and relating them to characteristics measured by descriptive sensory or physicochemical analyses is appropriate. Type of approach avoids what sometimes appears to be contradictory descriptions of products obtained from consumers and trained panels [14,15].

It has also been suggested that the meaning of freshness varies according to the background of the person who gives the definition. It can, therefore, be expected that opinion on freshness differs between professionals and consumers. Sensory attributes generated by a group of individuals specialized in the evaluation of freshness, but without knowledge on quality evaluation of products in general and on sensory analysis in particular, may better predict consumer perception of freshness rather than if these attributes were generated by professionals. In addition, freshness ratings of this small group could be an alternative to consumer tests.

#### 4. Conclusion

Interaction between genotypes and different planting locations toward carrot shelf life. Independently, planting locations showed a significant effect on carrot shelf life. Meanwhile, different genotypes showed a non-significant effect in carrot shelf life. All genotypes showed a non-significant difference in carrot shelf life. However, genotype F showed the longest shelf life three days, whereas genotype C showed the shortest shelf life two days at room temperature in Lembang.

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