Physico-chemical characteristics of shallot New-Superior Varieties (NSV) from Indonesia

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Abstract. Shallot is one of the priority agricultural commodities to be developed in Indonesia to reduce import and to stabilize domestic supply. The efforts include the selection of varieties, seed technology, agronomy, handling and processing to extend the supply and added value. Indonesian Agency for Agricultural Research and Development (IAARD) has purified, cross-pollinated, selected and released new varieties called New Superior Varieties (NSV) to farmers. The purpose of this research was to investigate the characteristic of fresh shallot NSV by understanding its potential for raw material of processed product. A completely randomized design (CRD) of single factor of ten local varieties of shallot such as Cv. Sembrani, Cv. Kuning, Cv. Pancasona, Cv.Bima, Cv. Trisula, Cv. Pikatan, Cv. Katumi, Cv. Kramat-2, Cv. Mentes and Cv. Majalok of three replication was used to arrange the experiment. The results showed that shallot New Superior Varieties (NSV) were significant by effect the physico-chemical parameters, such as diameter, length, weight of both in main bulb and tiller bulb, fat total, carbohydrate, crude fiber, starch content, antioxidant capacity and quercetin. Of the ten varieties of shallot characterized, the largest bulbs are Cv. Sembrani i.e 5.30 ± 0.3g per bulb, the best red color for shallot peeled was Cv. Kuning. Furthermore Cv. Pancasona have the highest protein content of 4.23 ± 0.2%, Cv. Mentes have the highest functional properties of quercetin 1766.4 ± 134 ppm. Shallot varieties such as Cv. Sembrani, Cv. Bima, Cv. Kuning and Cv. Trisula suitable for use as fresh product. Shallot varieties such as Cv. Pikatan, Cv. Pancasona, Cv. Katumi and Cv. Kramat-2 are suitable as raw materials for processed products. Cv. Mentes and Cv. Majalok were potential for raw materials of functional food and pharmaceutical industries.

Keywords: shallot, characteristics, NSV (New-Superior Varieties), Physico-chemical

1. Introduction

The fluctuations of price and scarcity in the market is a problem that occurs in shallot commodity in produced Indonesia. This is caused by crop failures by climate, natural disasters, mafia involvement, and are easily damaged. Shallot price fluctuations occur almost in year-round. The first is associated with the celebration day like Eid Mubarakan, Christmas, New Year Eve, long holidays and imports action. Usually shallot is imported when farmers are harvesting, so the price of this commodity would fall and fluctuate.
Shallot is one of strategic horticultural commodities in Indonesia. The average of shallot consumption in Indonesia reaches 4.6 kg per capita per year. Almost all households are known to consume shallot as spices every day. In addition to flavor reasons, some people consume shallot because of the nutrition contained in shallot such as: calcium, phosphorus, vitamin C, and beta-carotene [1]. Shallot production in Indonesia in the last five years tends to increase continuously.

Shallot is one of the priority of agricultural commodities is being developed in Indonesia to reduce import and to stabilize domestic supply. The efforts include the selection of varieties, seed technology, agronomy, handling and processing to extend the supply and added for value. IAARD has purified, cross-pollinated, selected and released new varieties called New Superior Varieties (NSV). These superior varieties are still able to be productive despite being planted out of season. These varieties include Cv. Bima, Cv. Trisula, Cv. Katumi, and Cv. Sembrani [2].

Consumers prefer shallot with characteristics of large tuber size (8-10 g / bulb), have a shiny red skin color and a short harvest age. New varieties will have different characteristics both size and nutrients. Characterization is needed to determine the suitability of shallot varieties for fresh consumption, for processing and which have high functional content as raw materials for the pharmaceutical industry. The purpose of this research was to investigate the physico-chemical characteristic of various shallot varieties from Indonesian Research Institute for Vegetable Crops collections.

2. Materials and Methods

2.1. Material and equipment

Raw materials consisted of ten varieties of local shallot, nine varieties were obtained from Indonesian Research Institute for Vegetable Crops Lembang, were Cv. Pancasona, Cv. Kuning, Cv. Katumi, Cv. Mentes, Cv. Majalok, Cv. Pikatan, Cv. Trisula, Cv. Sembrani, and Cv. Kramat-2 while one variety (Cv.Bima) obtained from farmers in Brebes.

Chemicals for analysis were consisted of DPPH the 2,2-diphenyl-1-picrylhydrazyl, methanol, ascorbic acid, folin-ciocalteau, quercetin standard, acetonitrille, sulfuric acid and sodium hydroxide. Equipment in this research were caliper, ruler, scales, filter paper, soxhlet, kjeldahl, spectrophotometer, chromameter, oven, furnace, HPLC and cuvettes.

2.2. Research methodology

Bulb and tiller shallots were removed from the bunch then sorted and selected and more good quality. Physical characteristic of each variety was taken from about 100 bulbs with 6 replication. These characterization included bulb length (cm), bulb diameter (cm), bulb weight (g), skin color (description), and number of tiller bulbs.

Next, Samples were analysed for proximate such as moisture content, ash content, fat total, protein, carbohydrate, crude fiber and starch [3], functional compound including DPPH [4] and quercetin [5]. This research was used to arrange the experiment was a Completely Randomized Design single factor i.e. varieties with three replication. The result of analysis was calculated of standard deviation and then significance by using Minitab 14 software.

3. Results and Discussion

3.1. Physical Characteristics of Various Shallot

Physical characteristics of various shallot NSV were presented at Table 1. The results showed that varieties of shallot showed were significantly effect on parameters, such as diameter, length, weight of both in main bulb and tiller bulbs. However, varieties did not significantly effect to the number of bulbs.
Differences in the size of the shallot bulbs are influenced by the genetic factors of each variety. Shallots from different varieties that are planted on the same soil will produce different bulb sizes [6].

The largest horizontal diameter of main bulb is on Cv. Sembrani varieties of 3.08 cm while the lowest is Cv. Mentes varieties of 1.35 cm. Indonesian National Standard requires quality of bulb diameter is 1.7 cm and the grade II is 1.3 cm. The varieties which are classified on quality I was Cv. Sembrani of 2.3 cm, while the others variety Cv. Bima, Cv. Kuning and Cv. Trisula were classified in quality II. The largest diameter of segment bulb was Cv. Sembrani of 2.30 cm and the shortest was Cv. Majalok Lembang and Cv. Katumi, only one tiller of each variety. The largest diameter of segment bulb was Cv. Sembrani of 2.30 cm and the shortest was Cv. Katumi which is 1.15 cm. The largest weight of bulb weight was Cv. Sembrani varieties 12.59 g and the lowest was Cv. Mentes of 2.35 g (Table 1). The irrigation and fertility levels influenced the production of different grades of onion bulb considerably [7].

The highest number of segmen bulb shallot were on Cv. Pikatan, Cv. Pancasona and Cv. Mentes, three segmen of each variety, while the least were Cv. Majalok Lembang and Cv. Katumi, only one tiller of each variety. The largest diameter of segment bulb was Cv. Sembrani of 2.30 cm and the shortest was Cv. Katumi 0.80 cm. The largest length of segment bulb length was Cv. Trisula of 3.03 cm, and the shortest was Cv. Katumi which is 1.15 cm. The largest weight of bulb weight was Cv. Sembrani varieties of 5.30 g and the lowest was Cv. Katumi of 0.41 g.

The color of shallots were pale red to dark red usually, except Cv. Sembrani has a yellowish red color. Shallots that have a pale red color are varieties of Cv. Mentes and Cv. Pikatan. The highest intensity of shallot color is Cv. Kuning, the other varieties are red color. The red color is caused by the anthocyanin pigment content. Anthocyanin tends to be unstable and easily degraded by various factors. These factors include light, pH, temperature, sulfite, ascorbic acid, enzymes, and others. Increased stability of anthocyanins can be done by binding of o-glycosidic, the presence of acyl groups in sugar molecules, the presence of metal ions, self-association, copigmentation, and encapsulation [9]. Thiosulfinate is a precursor pigment on the red onion [10]. Thiosulfinate can interact with anthocyanin with its own association (Asosiated-self). Such interactions can increase the stability of anthocyanins.

Another factor that makes the anthocyanin unstable is its own association factor and pH. The association itself is the interaction between anthocyanins with different copolymers that can affect the color and stability of anthocyanins. The mechanism of anthocyanin stabilization with its own association is closely related to the pH factor. Anthocyanins are more stable at lower pH (acid) than in high pH.
(alkaline). The ionic group of anthocyanins activates molecular structure changes depending on the pH state which will result in color differences in different pH conditions.

The color of shallot bulbs is likely to be stable, it will be unstable when the cell of shallot is damaged due to the processing or mechanical damage. Generally consumers prefer the color of shallots, the higher red color intensity will be favored by consumers. However, if shallots are used as raw material, the color can be improved through several treatments such as soaking process or addition with ingredients such as citric acid. The examples of shallot products that have been using this application are shallot paste, dried shallot slices and whole shallot in brine. The visual color of the various shallot new superior varieties (NSV) are presented at Figure 1.

![Figure 1. The red color level of various shallot NSV](image)

3.2. Chemical and Functional Compound Characteristics of Various Shallot New-Superior Varieties (NSV)

The results showed that varieties of shallot were significantly effect on the parameters, among others were fat total, carbohydrate, crude fiber, starch content, antioxidant capacity and quercetin. However, varieties were not significantly different on water content, ash content and protein (Table 2). Onion has different nutritional compositions depending on the variety and stage of maturity among others [11]. The drying conditions such as flavor and nutritional composition during processing or storage [12].
Water content is an important factor that can affect the quality of a product. The lowest water content was Cv. Kuning that was 80.03% and the highest was Cv. Majalok variety of 87.54%. Water content in fresh onion commodities must be in accordance with the standard, the water content is too low will reduce the weight of the product. Water content of shallot according to SNI 01-3159-1992 is 80% - 85% [13]. Some shallot varieties were not comply with the standard for moisture content. They were Cv. Pikatan, Cv. Pancasona, Cv. Trisula, and Cv. Majalok, however moisture content can be decreased through the drying process. Onion has a moisture content of 84.55 to 86.07% [8], this value is equivalent to the water content of VUB variety shallot. According to the USDA National Nutrient Database for Standard Reference (USDA, 2007) water content were 89.11% [14]. The lower water content of shallots will have better quality. Low water content can reduce the growth of microbes that can reduce the quality of the product [15].

The lowest ash content was Cv. Bima of 0.55% and the highest was Cv. Majalok of 0.8%. Ash content describes the mineral content contained in the material after the material is burned to be free of carbon [16]. This is not a parameter required in the Indonesian National Standard, but the determination it in the food is important to do. It is because ash content determines the mineral content present in the food. The higher the mineral content contained in food, the higher ash content present in the food. Shallots contain minerals include potassium of 334 mg / 100g, 0.80 g / 100g of iron and phosphorus of 40 mg / 100g. In contrast to onion, the most important minerals are potassium, calcium and selenium [11].

According to the USDA National Nutrient Database for Standard Reference (USDA, 2007) ash content are 0.35%[14].

The lowest fat content is Cv. Sembrani that is 0.03% and highest is Cv. Pancasona varieties equal to 0.59%. Fat is almost found in all food with different content. Shallot contain low fat, usually in the form of essential oils, but these fats can cause problems in processing such as shallot flour, this product will be clumping after being stored. According to the USDA National Nutrient Database for Standard Reference (USDA, 2007) total fat content are 0.1%[14].

The lowest protein content was Cv.Kuning of 0.9% and the highest was Cv.Pancasona of 4.23%. Proteins serve as anthocyanin precursors that contribute to red color. The anthocyanin comes from one of the amino acids, phenylalanine. Phenylalanine is one of the protein amino acids. Anthocyanin in form of cyanidin 3-glucoside [17]. Protein content is proportional to the concentration of anthocyanin in the shallot flour. Protein in the onion ranges from 0.96% to 1.04% [8]. This value tends to be lower than some varieties of NSV varieties. According to the USDA National Nutrient Database for Standard Reference (USDA, 2007) the total protein content are 1.1%[14].

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### Table 2. Chemical and functional compound characteristics of various shallot NSVs

| N o | Varieties   | Water content (%) | Ash content (%) | Fat (%)  | Protein (%) | Carbohydrate (%) | Crude fiber (%) | Starch (%) | Quercetin (ppm) | DPPH (ppm) |
|-----|-------------|-------------------|-----------------|----------|-------------|------------------|----------------|------------|-----------------|------------|
| 1   | Pikatan     | 87.17±0.3a        | 0.69±0.01a      | 0.05±0.01a| 3.13±0.1b   | 8.96±0.5c        | 1.90±0.2a       | 4.15±0.4bc | 1490.35±67.3f | 19.85±0.88c |
| 2   | Pancasona   | 86.45±0.2a        | 0.65±0.01a      | 0.59±0.014| 4.23±0.2b   | 8.08±0.3a        | 1.99±0.1a       | 4.23±0.3bc | 1612.22±54.3g | 19.88±0.58c |
| 3   | Kuning      | 84.93±0.2ab       | 0.65±0.01a      | 0.19±0.02b| 2.36±0.1ab  | 11.87±0.4g       | 2.25±0.2bc      | 4.73±0.5d  | 304.89±21.6b  | 24.45±0.63d |
| 4   | Trisula     | 87.10±0.2a        | 0.73±0.02ab     | 0.34±0.02c| 3.41±0.2b   | 8.44±0.5b        | 2.03±0.3ab      | 4.01±0.4b  | 499.68±31.8a  | 53.99±0.47h |
| 5   | Majalok     | 87.54±0.1a        | 0.80±0.01b      | 0.38±0.01c| 2.26±0.2ab  | 9.01±0.2d        | 2.10±0.2b       | 4.40±0.2c  | 199.68±31.8a  | 53.99±0.47h |
| 6   | Sembrani    | 80.03±0.2b        | 0.75±0.01ab     | 0.07±0.02a| 3.16±0.1b   | 15.99±0.3b       | 2.61±0.2d       | 3.44±0.3a  | 705.85±78.2d  | 11.86±0.19b |
| 7   | Kramat-2    | 81.83±0.2b        | 0.73±0.01ab     | 0.26±0.02b| 0.90±0.1a   | 16.33±0.3i       | 2.06±0.2a       | 4.40±0.3c  | 704.07±97.7d  | 38.77±0.53f |
| 8   | Mentas      | 84.33±0.1ab       | 0.73±0.02ab     | 0.18±0.02b| 2.75±0.2b   | 11.92±0.2g       | 2.29±0.2c       | 4.20±0.40c | 1766.4±154g  | 33.28±0.20g |
| 9   | Bima        | 85.36±0.1ab       | 0.63±0.01a      | 0.03±0.02a| 2.47±0.1ab  | 11.49±0.3f       | 2.43±0.3c       | 4.38±0.2bc | 1151.7±100.01e | 93.9±0.99c |
| 10  | Mentes      | 85.96±0.1ab       | 0.55±0.1a       | 0.07±0.02a| 3.89±0.2b   | 10.93±0.7e       | 2.23±0.2bc      | 4.04±0.1b  | 443.74±20.3c  | 28.58±0.77c |
The lowest carbohydrate content was Pancasena variety which was 8.08% and the highest was Cv. Kramat-2 of 16.33%. According to the USDA National Nutrient Database for Standard Reference (USDA, 2007) total carbohydrate content are 9.34% [14]. Shallots with high carbohydrate were suitable as raw material for producing both of dried slices and flour. In the processing of both products will be produced 10-12% of yield. In contrast to instant shallot flour made with a drum dryer with the addition of tapioca as filler will result more than 70% of yield [18].

The lowest crude fiber content was Cv. Pikatan of 1.90% and the highest was Cv. Sembrani of 2.43%. Crude fiber is the amount of fiber mass in foods, they were resistant to strong acids and strong alkalines. In food products, crude fiber content is always lower than dietary fiber. This is because strong acids such as sulfuric acid and strong alkalines such as sodium hydroxide have a greater ability to hydrolyze food components if they were compared to digestive enzymes [19]. The crude fiber contributes to the crispness of the shallot. Shallots with have a high coarse fiber are suitable for preserved in wholes and slices in brine products. According to the USDA National Nutrient Database for Standard Reference (USDA, 2007) dietary fiber content are 1.7% [14].

The lowest level of starch was Cv. Kuning was 3.44% and the highest was Cv. Katumi of 4.73%. Nutrients component such as fats, proteins, carbohydrates, crude fiber and starch were not included in the parameters required in fresh shallot Indonesian National standard.

The lowest antioxidant capacity was Cv. Katumi varieties that was 9.72 ppm and the highest was Cv. Majalok of 53.99 ppm. Previous studies were showed that the antioxidants present in the shallot are quercetin 3,4-dipecoside and quersetin 4-monoglucoside [20]. Antioxidants in shallot contribute to inhibit of browning reaction. This is important when the shallot will be processed into another product. If in the process we will require of slicing or destructing, then it will cause injured shallot cells so will accelerate the oxidation processed and the color will turn into brownish.

Antioxidants may be enzymes (SOD, catalase, and glutathione peroxidase), vitamins (A, C, E, and B-carotene), and other compounds (flavonoids, etc.). Enzymatic antioxidants are a major defence system against oxidative stress conditions. Non-enzyme antioxidants can be nutritional compounds and nutrients. Vitamin C (L-ascorbic acid) is a water-soluble antioxidant [21].

The quantitative determination of antioxidant activity can be determined by DPPH (Diphenylpicrylhydrazyl). DPPH is a free radical compound that reacts with antioxidants that donate one electron to form Diphenylpicrylhydrazine compound. The DPPH method measures the ability of an antioxidant compound in capturing free radicals. Previous research on the color of shallot flour has a positive correlation to the antioxidant activity. The antioxidant activity is related to the amino acid product which is the result of non-enzyme browning reaction during storage. If the amino acid decreases then the antioxidant activity to inhibit the peroxyl radicals in shallot flour will increase [22].

Shallots new-superior varieties (NSV) have wide range of quercetin content. The lowest level of quercetin was Cv. Majalok that was 199.68 ppm and the highest was Cv. Mentes 1766.4 ppm. Quercetin is one of the flavonoids found in shallot. The form of quercetin in onion flour is quercetin 7,4-diglukosida [17]. Quercetin may be used as an effective lipid peroxidation inhibitor after mirisetin and kaempferol. The quercetin content in the outer and inner sections of the shallot was 83477 ± 2879 mg / kg and 1926 ± 266 mg / kg [23].

Shallot contains phytochemical compounds, allisin, alliin, allil propel disulfide, phytosterol, flavonal, flavonoid, kaemfenol, quersetin, quercetin glycoside, pectin, saponin, and others [24]. Shallot nutrient composition is very complex, where it becomes one of the main sources of flavonoids in many countries. In particular, shallot contains quercetin flavonols and quercetin derives. In addition, it is rich in other bioactive compounds such as frutooligosacharida and sulfur compounds [2008]. The functional nature of shallot (antioxidant capacity and DPPH), is important to know if the shallot will be use as functional food or raw materials for the pharmaceutical industry. Allium species are rich in flavonols among which quercetin 3,41-o- diglucosidase represent the major components. Quercetin is known for its antioxidant and free radical scavenging power and its capability to protect agains cardiovascular deseases [26,27,28].
4. Conclusion

Shallots new superior varieties (NSV) were significantly effect on the physico-chemical parameters, such as diameter length, weight of both in main bulb and tiller bulb, fat total, carbohydrate, crude fiber, starch content, antioxidant capacity and quercetin.

Cv. Sembrani was one of variety of shallot which can be categorized in quality I in SNI for bulb diameter, meanwhile some varieties such as Cv. Bima Cv. Kuning and Cv. Trisula were categorized in quality II. Some varieties such as Cv. Katumi, Cv. Kuning, Cv. Kramat-2, Cv. Mentes, Cv. Sembrani and Cv. Bima have also within SNI based on their moisture content parameters.

Recommendations from this research:varieties such as Cv. Sembrani, Cv. Bima, Cv. Kuning and Cv. Trisula suitable for use as fresh product. Shallot varieties such as Cv. Pikatan, Cv. Pancasona, Cv. Katumi and Cv. Kramat-2 are suitable as raw materials for processed products. Cv. Mentes and Cv. Majalok were potential for raw materials of functional food and pharmaceutical industries.

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