The Paddy and Rice Quality of Three Varieties of Indonesian Local Aromatic Paddy

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Abstract. The purpose of this research was to study the physical, milling, nutrition quality and physichochemical characteristic of three Indonesian local aromatic paddy namely Kewal Balik Semah, Cere Mas, and Segara Anak. The research materials were obtained from local farmers in Lebak, Banten Province, and Sukamandi, West Java Province. The analysis was conducted at the Rice Quality Laboratory at Indonesian Center for Rice Research (ICRR), Sukamandi. The data were analysed using Analysis of Variance (ANOVA) and followed by Duncan’s Multiple Range Test (DMRT) if differences were found. The results indicated that paddy rice moisture content varied 11.5-13.4%, empty grain 2.0-9.4%, paddy density varied 339-568 g/l, 1000 grain weight range from 20.5-29.4 g, chalky + immature grain 0.2-0.7%, and yellow + damaged grain 0.7-5.3%, paddy length 5.2-6.04 mm (short to medium) and paddy L/B ratio ranged 2.04-2.41 (medium). Milling percentage ranged 62.5-71.5%, head rice percentage varied 56.7-85.4%, broken rice percentage ranged 14.5-41.0% and brewer 0.1-2.4%. Chalky grain <1% and damaged grain varied 0.07-0.4%. Milled rice whiteness ranged from 43.6-55.8%, and translucensy 0.5-2.8%. The amylose content of three varieties are categorised as medium amylose. Gel consistency characters is soft texture and gel temperature are high to high intermediate (1-3). Among of the cultivars the protein content ranged 7.4-8.2%.

1. Introduction
The aromatic rice is known not only in Indonesia but also in foreign countries. The superiority of aromatic rice to compete with non-aromatic rice is already visible in the commercial world. The exposure of names of aromatic rice such as Pandanwangi on local rice packaging labels, the rampant of a mixture of aromatic and non-aromatic rice with a certain ratio, and the practice of adding artificial aroma to non-aromatic rice, placed aromatic rice as candidate supplier of nutritional needs of the community that is not only useful in terms of nutrition but also satisfy the needs of a reliable inner. Unfortunately, the utilization of aromatic rice in Indonesia is still limited to complement non-aromatic rice for certain consumers only. In fact, aromatic rice is very popular in Southeast Asia, it is premium class of rice. The current aromatic rice so quickly penetrates overseas markets, especially the Basmati and Jasmine rice that has been so well known in European markets (the market with non-rice-eaters as the main food). Whereas existing or available aromatic Indonesian rice has been derived either from local rice or rice breeding, with varying physical and chemical properties [1][2]. The diversity of rice varieties gives us the opportunity to utilize them so as to increase the added value of the rice economy more significantly, not just, as a supplier of carbohydrates alone [3].

Aromatic rice is increasingly in demand by consumers because it has a more fragrant aroma than ordinary rice aroma. The fragrant aroma of rice caused by the 2-acetyl-1-pyrolidine (2-AP) compound is preferred because it can give a distinctive popcorn-like aroma [4]. This distinctive aroma that consumers
get an appreciation of the aspects of preference and price compared to non-aromatic rice. At the trade level, aromatic rice can increase consumer taste or behaviour so that it occupies a separate segment, which ultimately implies a more expensive selling price [5]. The existence of aromatic rice varieties in Indonesia has been known for a long time, the distribution is quite extensive and is favoured by farmers and household consumers because it has good quality, such as Rojolele dan Menthik Wangi (Central Java) Pandan wangi (West Java), Anak Daro/Kuniang Daro (West Sumatera), Kamba dan Lamale (Central Sulawesi), etc [6]. While the new superior rice varieties that exist today have also been produced by rice breeders, among others Celebes, Sintanur, Batang Gadis, Gilirang, Situ Patenggang, Hipa 5 Ceva, etc.

Characterization of many aromatic rice cultivars has been carried out, but is limited to agronomic properties, plant morphology and genetic related properties. Meanwhile, the characterization of physical, physicochemical and nutritional properties of aromatic rice has not been widely known. The purpose of this research was to study the physical, milling, nutrition quality and physichochemical characteristic of three Indonesian local aromatic paddy namely Kewal Balik Semah, Cere Mas, and Segara Anak.

2. Materials and methods
The materials used in this study were local aromatic paddy and rice, i.e. Kewal Balik Semah, Cere Mas, and Segara Anak. The research materials were obtained from local farmers in Lebak, Banten Province, and Sukamandi, West Java Province. The analysis was conducted at the Rice Quality Laboratory at Indonesian Center for Rice Research (ICRR), Sukamandi, West Java, Indonesia. The data were analysed using Analysis of Variance (ANOVA) and followed by Duncan’s Multiple Range Test (DMRT) if there was differences, using SPSS 16.0 software. The data were presented in average value. The identification physical characteristic of paddy are consist of moisture content, empty grain, paddy density, 1000 grain weight, chalky + immature grain, and yellow + damaged grain with IRRI method [7]. The identification of physical and milled rice are consist of yield of milled rice, percentage of head rice, broken rice, brewer (small broken), grain size and shape, whiteness and also grain translucency with IRRI method [7]. The identification nutrition quality and physicochemical characteristics are consist of protein, amylose content, gel consistency, and gel temperature. The analytical method used is in accordance with IRRI method [8] and [9].

3. Results and discussion

3.1. Physical paddy quality
High quality rice is influenced by the high quality grain. Moisture content is a physical grain quality component that plays a role in determining the shelf life. High moisture levels lead to grain damage due to chemical, biochemical and microbial processes. The grain moisture content of Kewal Balik Semah, Cere Mas and Segara Anak are below 14%, in accordance with Indonesian National Standard (INS) quality standard of paddy No. 0224-1087/SPI-TAN/01/01/1993 [10] (Table 1). The factors that influence the grain moisture content are conditions at harvest time and drying process. For empty grain, in the INS grain quality standard No. 0224-1987/S01-TAN/01/01/1993 is 3,0% for quality class III, so that the grain Kewal Balik Semah did not fulfill the standard.
Table 1. Paddy physical quality of Kewal Balik Semah, Cere Mas, and Segara Anak

| Paddy physical quality                  | Kewal Balik Semah | Cere Mas | Segara Anak | INS quality standard of paddy No. 0224-1087/SPI-TAN/01/01/1993 |
|----------------------------------------|-------------------|----------|-------------|---------------------------------------------------------------|
| Moisture content (%)                   | 13.4c             | 12.3b    | 11.5a       | I (%): 14, II (%): 14, III (%): 14                             |
| Empty grain (%)                        | 9.4b              | 2.0a     | 2.1a        | I (%): 1.0, II (%): 2.0, III (%): 3.0                        |
| Density (g/l)                          | 339a              | 532b     | 568c        | -                                                             |
| Weight of 1000 grain (g)               | 24.1b             | 20.5a    | 29.4c       | -                                                             |
| Chalky+immature grain (%)             | 0.5b              | 0.7b     | 0.2a        | I (%): 1, II (%): 5, III (%): 10                             |
| Yellow+damaged grain (%)              | 5.3b              | 0.7a     | 0.7a        | I (%): 2, II (%): 5, III (%): 7                              |

The number in one column followed by the same letter is not significantly different.

Density value is the other grain quality component. Grain density is a measure that describes the weight of grain for units of volume expresses in units of grams per liter (g/l). Measurement of density (g/l) of grain is useful to know the yield of milled rice. The higher the grain density value means the weight of grain for each unit of grain for each unit of the same volume is greater. This shows the level of filling of grain when in the optimal crop. The grain density of Kewal Balik Semah is 339 g/l lower than that of Cere Mas 532 g/l and Segara Anak 568 g/l. The range of paddy density of rice varieties in Indonesia ranges from 454.4-577.0 g/l [11]. The weight of 1000 grain of Kewal Balik Semah is 24.1 g higher than that of Cere Mas (20.5 g), but lower than Segara Anak (29.4 g). Grain density and weight of 100 grains have an effect on determining the yield of milled rice (Table 1).

The chalky+immature grain of Kewal Balik Semah is 0.5%, Cere mas is 0.7% and Segara Anak is 0.2% which are fulfill the standard for quality class I (maximum 1%). The yellow+damaged grain of Cere Mas and Segara Anak are 0.7% which are fulfill the standard for quality class I (maximum 2%) (Table 1).

3.2. Physical, milling, physicochemical properties and nutritional quality of milled rice

The physical quality of milled rice is characterized by a combination of desirable and measurable characteristics which are used to classify rice into grades which are in line with market requirement. The appearance of milled rice is important to consumers. Preferences for grain size and shape vary from one group of consumers to another. Some ethnic groups prefer short bold grains, some prefer medium-long grains, and others highly prize long slender. Generally consumers in Indian subcontinent prefer long grains, but, in Southeast Asia the demand is for medium to medium-long rice. In temperate areas, short grain varieties are prevalent. On the international market there is strong demand for long-grain rice [12].

Table 2 shows that length of milled rice statistically significant differences between Kewal Balik Semah, Cere Mas, and Segara Anak. Kewal Balik Semah include short rice (5.20 mm), Cere Mas and Segara Anak include medium rice (5.51-6.60 mm). [13] classifies the length of rice as follows: very long (>7.5mm), long (6.61-7.5mm), medium (5.51-6.60mm), and short (<5.50 mm). The length of Rojolele and Mentikwangi an aromatic varieties from Java were 6.9 mm and 6.1 mm (Indrasari et al., 2012). Based on [13] criteria, Rojolele and Mentikwangi were categorised as a length rice. [14] reported that the length of non pigmented (Keteki Joha) and pigmented (Poreiton Chakhao) aromatic paddy varieties from India were 5.82±0.03 mm (medium) and 6.51±0.03 (long) respectively determined as [15]. Based on Table 2 it is known that the ratio of length and width of Kewal balik Semah (2.04), Cere Mas (2.41), and Segara Anak (2.32) statistically significant differences. The ratio of length and width of the rice determines the classification of the grain shape. [13] classifies rice into 4 types: slender (>3.0), medium (2.1-3.0), bold (1.1-2.0), and round (< 1). Based on the classification, the shape of Kewal balik Semah, Cere Mas, and Segara Anak were medium. The rice shape of both Rojolele and Mentikwangi are medium (2.5 and 2.3) (Indrasari et al., 2012). According to [14] the rice shape non pigmented (Keteki joha) and pigmented (Poreiton Chakhao) aromatic paddy varieties from India were 2.91±0.01 (quasislender) and 3.25±0.06 (slender) respectively determined as per [15].
Table 2. Physical, milling, physicochemical properties and nutritional quality of Kewal Balik Semah, Cere Mas, and Segara Anak Milled Rice

| Physical quality | Kewal Balik Semah | Cere Mas | Segara Anak |
|------------------|-------------------|----------|-------------|
| L (mm)           | 5.20a             | 5.60b    | 6.04c       |
| W (mm)           | 2.55b             | 2.33a    | 2.61c       |
| L/W Ratio        | 2.04a             | 2.41c    | 2.32b       |
| Whiteness Degree (%) | 55.8c         | 43.60a   | 50.10b      |
| Transparency (%) | 1.2b              | 0.50a    | 2.80c       |
| Milling Degree   | 162c              | 105a     | 140b        |
| YOeld of Milled Rice (%) | 62.5a           | 65.7b    | 71.5c       |
| Head Rice (%)    | 65.1b             | 56.7a    | 85.4c       |
| Broken Rice (%)  | 33.8b             | 41.0c    | 14.5a       |
| Groat grain (%)  | 1.1b              | 2.4c     | 0.1a        |
| Chalky grain (%) | 0.07a             | 0.08a    | 0.09a       |
| Yellow + damage grain (%) | 0.4c          | 0.07a    | 0.31b       |

Physicochemical properties and Nutritional quality:

| Amylase (%)       | 22.9b             | 24.1c    | 22.3a       |
| Gel consistency (mm) | 66.0b         | 61.0a    | 69.0c       |
| Gelatinization Temperature (°C) | >74a           | >74a    | >74a       |
| Water Absorption Ratio (WAR) | 2.9c           | 2.6a    | 2.7b        |
| Volume Expansion Ratio (TER) | 3.4b           | 3.7c    | 3.2a        |
| Protein           | 7.5b              | 7.4a     | 8.2c        |

The number in one column in each sub topic followed by the same letter is not significantly different.

In general, consumers prefer rice with long grain and slender shape. Shape, size, weight and seed uniformity are important factors in the rice industry. The rice dimension determines in the international market because long rice has a high demand [16]. In addition, information on the ratio of length and width is required in determining drying and processing equipment.

In general consumers prefer white and transparant milled rice. The whiteness degree of Kewal Balik Semah (55.8%) was higher than that of Cere Mas (43.6%) dan Segara Anak (50.1%), while the transparancy of Kewal Balik Semah (1.2%) was lower than that of Segara Anak (2.8%), but was higher than that Cere Mas (0.5%) (Table 2). The rice transparant is determined by the genetic traits and the milling method. The use of friction method that is friction between rice grains will produce rice with a higher value of transparant than abrasive method that is friction with grinding stone. The milling degree of Kewal Balik Semah, Cere Mas, and Segara Anak statistically significant differences were 162, 105 and 140,5 based on Satake Milling Meter (Table 2). The milling degree is a joint criteria between the whiteness degree and the transparancy of rice grain. Increased levels of rice husking produce in higher milled rice with higher degrees. Measurement of milling degree is carried out using Satake Milling Meter. The whiteness degree, transparancy and milling degree of Rojofele and Mentikwangi respectively were 51.9%, 2.9%, 150 and 45.2%, 2.3%, 115 [17].

The yield of Kewal Balik Semah milled rice is 62.5% lower than that of Cere Mas (65.7%) and Segara Anak (71.5%) (Table 2). Head rice is a component of physical quality of rice that directly affects the level of acceptance by consumers. In general, consumers do not like milled rice with low head rice percentage. Standards of quality of milled rice based on Indonesian National Standard (INS) No. 01-6128-2008 for the IV quality class requires a minimum of rice head of 73% with moisture content of 14% [18]. When compared with the requirements of the INS, Kewal Balik Semah and Cere Mas doesn't met the requirements. The yield of milled rice is affected by grain density and weight of 1000 grains. The greater the density and weight of 1000 grains will result in a higher yield of milled rice [2].

Conversely with the head rice, high percentage of broken rice cause declining of consumer acceptance. For domestic food procurement, according to quality standards of milled rice (class IV quality), the maximum of percentage of broken rice is 25%. Thus Kewal Balik Semah and Cere Mas...
has not met the established requirement (Table 2). One of factors that determine the high broken rice in milled rice is moisture content. When grain was milling with low moisture content will cause high broken grain. Conversely, if too wet it will produce a high grain groats [2].

The percentage of groat grain of Kewal Balik Semah (1.1%) is lower than that of Cere Mas (2.4%) which is not fulfill the standard of class III (maximum 1%). The chalky grain of Kewal Balik Semah (0.07%), Cere Mas (0.08%), and Segara Anak (0.09%) have met the standard requirement for quality class III. The yellow+ damaged grain of Kewal Balik Semah (0.4%), Cere Mas (0.07%), and Segara Anak (0.31%) have met the standard requirement for quality class II (maximum 1%) (Table 2). The chalky grain is caused by physiological factors, genetic factors, young seeds (harvest age is not optimum, seed growth is less than perfect), easily damaged by pest attacks and low storage capacity and the yellow+damaged grain is caused by fermentation process, the growth of the fungus due to imperfect grain drying process after. Chalky grain, yellow+damaged grain are the components that consumers consider in choosing the rice they buy [2].

The amylose content of milled rice statistically significant differences between Kewal Balik Semah, Cere Mas, and Segara Anak. Kewal Balik Semah (22.9%), Cere Mas (24.1%) and Segara Anak (22.3%) include intermediate (20-25% amylose). The amylose content of starches in milled rice usually ranges from 15 to 35%. Based on amylose content, milled rice is classified as: waxy (1-2% amylose), non-waxy (>2% amylose), very low (2-19%), intermediate (20-25% amylose), and high (25-33% amylose) [13].

Gel consistency measures the tendency of the cooked rice to harden on cooling. Gel consistency is determined by heating a small quantity of rice in a dilute alkali. This test differentiates the consistency of cold 5.0% milled rice paste. Within the same amylose group, varieties with a softer gel consistency are preferred, and the cooked rice has a higher degree of tenderness. Rice is grouped into 3 groups based on the gel consistency, ie. consistency of hard gel (very flaky rices) with gel length <40 mm, flaky rices with gel length 41-60 mm, and low gel consistency (soft rices) with gel length >61 mm [19]. Harder gel consistency gel is associated with harder cooked rice and this feature is particularly evident in high-amylose rice. Hard cooked rice also tend to be less sticky. The gel consistency of Kewal Balik Semah (66 mm), Cere Mas (61 mm), and Segara Anak (69 mm) are soft (Table 2).

Gelatinization temperature is the time required for cooking the milled rice. It is estimated by the extent of alkali spreading. The degree of spreading is measured using a seven-point scale. The corresponds of alkali spreading value to gelatinization temperature as follows : 1-2, high (74.5 - 80°C), 3 high intermediate, 4-5, intermediate (70-74°C), and 6-7, low (<70°C). In Asia there is a normally a preference for rice with intermediate gelatinization temperature. The gelatinization temperature of Kewal Balik Semah, Cere Mas, and Segara Anak is the same (>74°C) that are high. The water absorption ratio and volume expansion ratio of Kewal Balik Semah are 2.9 and 3.4 consecutively, Cere Mas are 2.6 and 3.7 and for Segara Anak are 2.7 and 3.2 consecutively. The protein content of Kewal Balik Semah is 7.5%, Cere Mas is 7.4% and Segara Anak is 8.2% (dry basis) (Table 2).

4. Conclusions
The shape of Kewal Balik Semah, Cere Mas, and Segara Anak was medium. Kewal Balik Semah has higher yield and head rice percentage than those of Segara Anak. The amylose content of Kewal Balik Semah, Cere Mas, and Segara Anak was categorized as medium amylose that produce soft cooked rice.

5. References
[1] Adijono P, Kustianto B, Allidawati and Suwarno 1995 Pemuliaan padi aromatic dan Ketan p 422-428 Di dalam M Syam Hermanto A Mussyaddad dan Sunihardi (Eds): Kinerja Penelitian Tanaman Pangan, Buku 2 Padi- Bioteknologi, Pemuliaan dan Proteksi. Prosiding Simposium Penelitian Tanaman Pangan III. Pusat Penelitian dan Pengembangan Tanaman Pangan, Bogor
[2] Suprihatno BAA, Daradjat, Satoto, Baehaki N, Widiarta NA, Setyono A, SD Indrasari, OS Lesmana dan Sembiring H 2005 Deskripsi varietas Padi Balai Besar Penelitian Tanaman Padi Subang

[3] Indrasari SD 2017 Quality and volatile compound of aromatic rice variety Pandanwangi specific location Cianjur West Java Indonesia Proceeding of the 15th ASEAN Conference on Food Science and Technology November 14-17 2017 Ho Chi Minh City Vietnam 319-323

[4] Navarro M, V Butardo, C Boumphounsay, R Reano, RS Hamilton, H Verhoeven and M Fitzgerald 2007 The good, the BAD and the fragrant-understanding fragrance in rice Paper on Workshop International Network for Quality Rice International Rice Research Institute IRRI Los Banos-Philippines

[5] Suherman D 1999 Peningkatan nilai tambah pada prosesing produk tanaman pangan (beras) makalah seminar strategi peningkatan nilai tambah komoditi tanaman pangan dan hortikultura dalam antispasi pasar global era milenium III Dirjen Tanaman Pangan dan Hortikultura Dep. Pertanian Jakarta

[6] Ismail 2004 promosi beras mutu baik dari kultivar padi aromatik untuk meningkatkan ketahanan pangan daerah dan pelestarian biodiversitas Majalah Pangan 43/XIII Puslitbang BULOG Jakarta 54-55

[7] Anonim 2003 Concepts of rice quality Rice Quality Workshop 2003 www.plansciences.ucdavies.edu/rice/Quality/2003/Quality Concepts.pdf 9/1/2007

[8] IRRI 1996 Standard evaluation system for rice INGER Genetic Resources Center, International Rice Research Institute, Manila – Philippines

[9] AOAC 2000 Official methods of analysis of the association of official analytical chemists International William Horwitz and G W Latimer Jr (eds) Published by AOAC International Gaithersburg Maryland USA

[10] Badan Standarisasi Nasional 1993 Standar Nasional Indonesia Gabah SNI 0224-1987/SPI-TAN/01/01/1993 Jakarta

[11] Suismono, Setyono A, Indrasari SD, Prihadi W & Las I 2003 Evaluasi mutu beras berbagai varietas padi di Indonesia Balai Penelitian Tanaman Padi Subang Indonesia

[12] Graham R 2002 A proposal for IRRI to establish a grain quality and nutrition research center. International Rice Research Institute 15

[13] Juliano BO 2003 Rice in human nutrition The International Rice Research Institute and Food and Agriculture Organization of the United Nations Rome 162

[14] Saikia S, Dutta H, Saikia D & Mahanta CL 2012 Quality characterisation and estimation of phytochemicals content and antioxidant capacity of aromatic pigmented and non-pigmented rice varieties Food Research International 46 334-340

[15] Bhattacharya KR & Sowbhagya CM 1980 Size and shape classification of rice IRRiso 29 181-184

[16] Damardjati DS & Purwani EY 1991 Mutu beras Dì dalam: Padi Buku 3 Pusat Penelitian dan Pengembangan Tanaman Pangan Bogor

[17] Indrasari SD, Handoko DD, Kusbiantoro B, Jamalul & Ardhiyanti SD 2012 Mutu fisik mutu giling dan sifat fisikokimia beras-beras lokal aromatik di Indonesia Purnomo D et al (eds) Prosiding Seminar Nasional membangun negara agraris yang berkeadilan dan berbasis kearifan lokal Buku 2 99-110

[18] Badan Standarisasi Nasional 2008 Standar Nasional Indonesia Beras SNI 6128:2008 Jakarta

[19] Cruz NJ & Khush GS 2000 Rice grain quality evaluation procedures Dì dalam R K Singh et al (Eds): Aromatic Rice Oxford and IBH Publishing Co Pvt Ltd Calcutta. India 298