

Physico-chemical properties of black pepper from selected varieties in relation to market grades

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Black pepper (*Piper nigrum* L.), varieties 'Panniyur-1', 'Panniyur-2', 'Panniyur-5', 'Sreekara', and 'Subhakara' were graded in a hand operated rotary sieve cleaner-cum-grader. The grader was provided with 3 sets of sieves with pore size of 3.5, 3.8 and 4.8 mm placed one after the other in the increasing order. The variety 'Subhakara' had highest amount of berries of size between 3.8 and 4.8 mm (33.3%) which belongs to TGSEB (Tellicherry Garbled Special Extra Bold) grade. 'Panniyur-1', 'Panniyur-2' and 'Panniyur-5' had more than 60 % of its berries under the grade TG (Tellicherry Garbled). Bulk density ranged from 450 to 571 g/l. Bulk density increased with increase in size. However, bulk density decreased when the berry size was > 4.8 mm. The starch content increased as the grade size increased whereas protein and crude fibre did not show any consistent trend. The oleoresin and piperine contents were highest for the lower grade (<3.5 mm) but the oil content was not related to grade in all the varieties.

Keywords: Black pepper, Grades, Quality

Black pepper (*Piper nigrum*) berries after harvest are separated from spike and dried under sun to get commercial black pepper. It is a highly valued commercial spice and during the year 2005-06 India exported 16,700 tons of black pepper valued at Rs.14,050 lakhs (Anon 2007). Black pepper exported from India is graded as per Agmark standard grades (Jayashree 2005) or ASTA (1968) using multiple sieves. Grading is generally the process of separation of mixtures into their more homogeneous fractions. The purpose of grading is to aid product standardization and to facilitate marketing. Grading by human eye judgment or manual separation process is quite difficult and time-consuming resulting in high operational cost. The major advantages of grading agricultural commodity are to control substandard material in the main lot to maintain the selling price and to limit the supply of low grade goods to ensure fair competition. Major Agmark grades of black pepper are Tellicherry Garbled Special Extra Bold (TGSEB), Tellicherry Garbled Extra Bold (TGEB), Tellicherry Garbled (TG), Malabar Garbled (MG-I) and Malabar Garbled (MG-II). The grades are fixed based on the size of the berries (Sikka et al 1984). TGSEB grade has berries of size > 4.8 mm, TGEB grade has berry sizes of 3.8-4.2 mm, TG grade has berry sizes of 3.2-3.7 mm and MG grade has berries < 3.5 mm. Generally cleaning and grading are done at the traders or exporters level before packing or further processing.

Post-harvest procedures can improve the quality of the commodity (Cavaliere 1999). The farm level cleaning and grading of black pepper is restricted to manual winnowing to remove dust, chaff or any other light materials. In the absence of well-defined grading system at field level, the producers do not get prices commensurate with the quality of the pepper produced. Grading and quality based price structure can encourage the farmers to get better returns. Hence-the objective of the present study was to grade 5 popularly grown varieties of black pepper at the farm level and to assess quality parameters of various grades.

Materials and methods

Freshly harvested and dried black pepper (*Piper nigrum* L.) varieties: 'Panniyur-1', 'Panniyur-2', 'Panniyur-5', 'Sreekara' and 'Subhakara' were collected from experimental farm of the institute at Peruvannamuzhi. Primarily cleaned black pepper was graded through a rotary cleaner-cum-grader of capacity 15 kg (Amaladhas et al 2004). The circumference of the screw assembly was provided with 3 sets of sieves having perforations of sizes 3.5, 3.8 and 4.8 mm diameter. These sieves were arranged in the increasing order of perforations continuously along the length of the grader from the feed end to the discharge end so that the smaller size berries graded first and larger berries graded last. The sieve assembly was manually rotated by a shaft with extended handle.

About 15 kg of each variety was graded 3 times in the above grader at the optimum recommended operating speed of 25 rpm. Samples were collected from each outlet as per the sieve size. Bulk density was determined by Ravindran (2000) procedure. The samples were analyzed for primary metabolites like starch, protein and crude fibre and for secondary metabolites like essential oil, oleoresin and piperine. Starch was estimated by the Anthrone method and protein by Lowry's method (Sadasivam and Manickam 1992). Crude fibre, essential oil and oleoresin were estimated by ASTA (1968) method. Piperine was estimated by HPLC method (Wood et al 1988). Essential oil constituents were separated in a Perkin Elmer Autosystem gas chromatograph using Total Chrom Autosystem XL GC IPM 1204-WS0084 software (oven programme:70-210°C @ 5°C/min, column- OV-17, detector-FID at 300°C and injection port at 200°C). The compounds were identified using Sigma standards.

Results and discussion

Distribution of varieties in different grades: In all 5 varieties graded, > 50% of the berries was of the size 3.5 to 3.8 mm (Table 1). The variety 'Subhakara' had the highest quantum of the berries of size 3.8 to 4.8 mm (33.3%) followed by 'Panniyur-1' (25.8%), 'Panniyur-2' (25.4%), 'Sreekara' (21.7%) and 'Panniyur-5' (16.8%). The grade size normally comes under the commercial made TGEB and TG as per AGMARK grading. The variety

Table 1. Physical properties of black pepper varieties of different grades

Grades, mm	Pepper varieties				
	P ₁	P ₂	P ₃	P ₄	P ₅
	Size distribution, %				
< 3.5	8.7	9.5	17.4	13.9	20.1
3.8	65.2	64.5	65.4	51.9	57.9
4.8	25.8	25.6	16.8	33.3	21.7
> 4.8	0.40	0.4	0.3	0.9	0.3
	Bulk density, g/l				
< 3.5	472.8	513.6	508.0	515.0	515.0
3.8	505.3	555.3	526.0	531.0	552.0
4.8	513.3	571.6	553.3	545.0	560.0
> 4.8	454.7	460.0	450.0	475.0	470.1

P₁: 'Panniyur-1', P₂: 'Panniyur-2', P₃: 'Panniyur-5', P₄: 'Subhakara', P₅: 'Sreekara'

'Subhakara' had the highest amount of berries of size more than 4.8 mm (0.9%) followed by 'Panniyur-2' (0.4%) and 'Panniyur-1' (0.4%). This grade is commonly called as the TGSEB. The varieties 'Panniyur-1', 'Panniyur-2' and 'Panniyur-5' had more than 60% of berries of size 3.8 mm which is normally called as TG grade. The MG grade i.e. berry size less than 3.5 mm was obtained lowest in 'Panniyur-1' (8.7%) and highest in 'Sreekara' (20.1%).

Relation between bulk density and grades: The bulk density increased with the increase in grade size up to 4.8 mm and beyond this the bulk density decreased (Table 1). It varied from 450 to 570 g/l. The lower bulk density of grade above 4.8 mm can be attributed to less number of berries that will be present in a given volume due to the bigger size of the berries.

Interaction between grade and primary metabolites: The starch content ranged from 34.7 to 52.3% and was more in higher grades, protein content varied from 9.6 to 13.9% and fibre content from 6.8 to 14.6% (Table 2). There was no specific trend with respect to any particular grade in its primary metabolites content. No significant variation was seen between grade and primary metabolites. Distinct variations were observed with respect to varieties.

Influence of grade on secondary metabolites: The essential oil content showed no variations within the grades in all the varieties except in 'Panniyur-2', where the highest grade (> 4.8 mm) showed increased essential oil content of

Table 2. Primary and secondary metabolites of black pepper varieties of different grades

Grades, mm	Pepper varieties				
	P ₁	P ₂	P ₃	P ₄	P ₅
	Starch, %				
< 3.5	34.7	45.9	51.5	46.8	37.0
3.8	38.5	47.4	46.0	45.6	45.6
4.8	43.5	36.5	52.3	30.7	46.7
> 4.8	47.5	53.5	46.8	46.9	47.1
	Protein, %				
< 3.5	13.6	11.1	11.3	10.7	9.7
3.8	11.8	10.3	12.4	11.1	9.6
4.8	9.7	12.5	13.8	10.7	9.9
> 4.8	11.0	14.1	10.9	13.9	10.8
	Fiber, %				
< 3.5	14.6	9.3	9.2	11.3	11.4
3.8	11.8	6.8	9.0	10.4	9.1
4.8	12.0	6.9	7.2	10.3	9.2
> 4.8	13.4	11.1	10.8	11.2	9.9
	Essential oil, %				
< 3.5	3.3	2.4	2.4	3.3	3.3
3.8	3.3	2.4	2.4	3.0	3.0
4.8	3.3	2.4	2.4	3.0	3.0
> 4.8	3.3	3.0	2.4	3.0	3.0
	Oleoresin, %				
< 3.5	12.2	9.3	9.2	8.5	8.8
3.8	11.3	9.3	9.3	8.3	8.3
4.8	10.4	9.3	8.2	8.2	8.7
> 4.8	10.5	8.9	8.6	7.9	8.2
	Piperine, %				
< 3.5	4.4	4.2	4.1	3.9	4.2
3.8	3.8	4.4	3.9	3.7	3.8
4.8	4.1	3.7	3.6	3.4	3.5
> 4.8	3.7	3.6	3.5	2.8	3.5

P₁-P₅: As in Table 1

3% for highest grade compared to 2.4% for the lower grades (Table 2). The oleoresin content decreased with increase in grade size and highest oleoresin content was in the grade less than 3.5 mm. Piperine content decreased with the increase in grade size and highest piperine content was in the grade less than 3.5 mm.

The major chemical constituents present in essential oil of black pepper are pinene (5.4-9.2%), sabinene (17.8-26.1%), myrcene (1.2-16.7%), limonene (17.3-24.6%) and β-caryophyllene (19-26.1%) (Table 3). No significant variations in the essential oil constituents with respect to their size were observed. Variability was observed more in relation to varieties rather than grades. In 'Panniyur-1' sabinene and myrcene were not clearly separated and hence reported as sabinene. Even though slight increase was found in

Table 3. Major chemical constituents of essential oils in black pepper varieties of different grades

Grades, mm	Pepper varieties				
	P ₁	P ₂	P ₃	P ₄	P ₅
	Pinene, %				
< 3.5	7.4	8.8	6.8	6.5	5.7
3.8	7.4	9.0	6.4	6.6	5.4
4.8	7.3	9.2	5.9	5.9	5.4
> 4.8	7.5	8.8	5.4	5.8	5.4
	Sabinene, %				
< 3.5	22.2	23.5	19.5	18.6	18.9
3.8	21.3	26.0	18.6	18.9	18.8
4.8	21.2	26.1	18.4	18.9	18.7
> 4.8	21.2	25.7	17.9	17.8	19.7
	Myrcene, %				
< 3.5	-	6.3	14.2	16.7	13.2
3.8	-	2.2	13.9	13.9	10.2
4.8	-	2.2	12.9	13.4	8.3
> 4.8	-	1.2	12.1	12.6	4.2
	Limonene, %				
< 3.5	20.8	22.2	18.4	22.8	18.3
3.8	20.4	24.4	17.4	17.8	17.9
4.8	19.9	24.1	17.3	20.7	21.9
> 4.8	19.3	24.6	17.9	18.5	18.7
	β-Caryophyllene, %				
< 3.5	24.6	22.7	22.3	19.0	22.1
3.8	25.8	24.8	22.6	22.6	24.6
4.8	24.6	24.4	23.0	22.3	24.2
> 4.8	25.6	26.1	23.8	24.3	26.0

P₁-P₅: As in Table 1

oleoresin and piperine content in lower grade, no such difference was observed for volatile oil constituents. β-Caryophyllene, the main flavour constituent of black pepper oil was found consistent in all the 'Panniyur' varieties.

The maturity of black pepper has been studied and reported by various workers (Govindarajan 1976, Sumathykutty et al 1979). The major constituents of black pepper were reported as starch, crude fibre and fat, but the most significant ones from the point of view of quality was reported to be the pungent principle piperine and essential oil. Sumathykutty et al (1982) have analysed different grades of four black pepper cultivars i.e. 'Panniyur', 'Kalluvally', 'Karimunda' and 'Kottanadan'. The grades TG and MG gave comparable values with respect to volatile oil and extractives whereas piperine content was higher in MG grade. The TGSEB had slightly lower values for volatile oil, extractives and piperine values compared to TG and MG grade.

The volatile oil constituents of different cultivars of black pepper have been studied by many authors. Menon et al (2000) identified 55 compounds in the oils of 4 pepper cultivars namely, 'Karimunda', 'Kalluvally', 'Arakulamunda' and 'Thommankodi' by GC and GC/MS. The main components reported were α-pinene (2.4-11.4%), β-pinene (2.0-15.27%), δ-2 carene (0.1-21.0%), limonene (9.4-21.9%) and β-caryophyllene (19.8-45.3%). Kurian et al (2002) reported 5% essential oil and 9.4% oleoresin in 'Panniyur-5'. Menon et al (2002) reported α-pinene, β-pinene, δ-3-carene, limonene and β-caryophyllene as major compounds in 'Karimunda' oil. They had reported up to 45% β-caryophyllene. Menon et al (2003) identified 55 compounds in the oil of four major black pepper cultivars namely, 'Thevanmudi', 'Poonjaranmunda', 'Valiakaniakkadan' and 'Subhakara' and reported β-caryophyllene (20-34%), sabinene (4.5-16%), limonene (14.9-15.8%) and α-pinene (3-6.5%). Radhakrishnan et al (2004) studied 7 black pepper cultivars namely, 'Panniyur-2', 'Panniyur-3', 'Panniyur-4', 'Sreekara', 'Subhakara', 'KS-88' and 'Neelamundi' for yield and constituents such as piperine, oleoresin and essential oil. 'Panniyur-4' recorded highest yields of 2,101 kg/ha, the lowest oleoresin of 9.2%, piperine of 4.4% and contained 2.2% of essential oil. Singh Gurdip et al (2004) reported 49 components in pepper oil. Major components were β-caryophyllene (24%), limonene (16.8%), sabinene (13%), β-bisabolene (7.6%) and α-copaene (6.3%).

Conclusion

'Panniyur-1', 'Panniyur-2' and 'Panniyur-5' varieties of black pepper had more than 60% of its berries in the grade 3.8 mm which can be put under TG grade. The variety 'Subhakara' had about 33.3% of its berries of size 3.8-4.8 mm or above

which comes under TGSEB grade. The bulk density of the graded black pepper in all the varieties studied increased with increase in the size up to 4.8 mm beyond which it decreased. The primary metabolites like protein and crude fibre did not show consistent trend with respect to grade. However, starch content increased with increase in grade size. The secondary metabolites like oleoresin and piperine contents were higher for the lower grade (3.5 mm) in all 5 varieties. But the essential oil content remained unchanged irrespective of grade. However, no significant difference in quality was observed between grades.

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