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Influence of harvesting stage and drying on quality of *Piper chaba* Hunter

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Key words: *Piper chaba*, maturity, drying, moisture content, volatile oil, oleoresin, piperine, starch.

Java long pepper (*Piper chaba* Hunter) is a glabrous, fleshy climber with adhesive roots, native of the Moluccas, commonly found in Indonesia and North Eastern parts of India. The fruiting spikes are erect, cylindro-conic, widest at base, bright red when ripe and 2.5 – 7.5 cm long (Ravindran, 2000). The fruits are formed of laterally fused seeds. The fruit is thick green during the initial stages of development, which subsequently turns orange and then into deep red on ripening. Long pepper traded in India is derived from two or three species, including *Piper longum* and *Piper chaba*. The products of these species are used for the same purposes, though they vary in their effectiveness. Chaba is widely used in ayurvedic medicine as a stimulant and carminative and in the treatment of cough, cold and haemorrhoidal affliction. It is also given for colic and renal diseases.

The fruits have a weak aromatic odour and a pungent flavour somewhat resembling black pepper, but comparatively weaker. *P. chaba* is similar in composition to black pepper but contains less piperine and volatile oil.

Dried *P.chaba* yields on steam distillation about one per cent of a light green volatile oil with an odour reminiscent of that of black pepper and ginger oil (Krishnamurthi, 1969). Piperine present in the spikes imparts pungency and biting taste to the spice. Piperine is reported to have many pharmacological and antimicrobial properties. The mature spikes are more pungent and lose its pungency and quality on ripening (Ravindran, 2000). Other major quality constituents of the spice are oleoresin, starch, etc. Oleoresins are concentrated products representing the total flavour of the spice and are obtained by solvent extraction. These are blends of volatile oil and resinous matter made up of pungent principles, colours, fixed oils, etc. The moisture content of fresh *P. chaba* is as high as 70 per cent.

Work on post harvest processing of *Piper chaba* is very limited and this work is a venture into the drying and quality aspects of *P. chaba*. This study was also aimed at identifing the best stage of harvesting of spikes to obtain a dried product of superior quality.

Fresh spikes were harvested at three stages of maturity namely; mature (green and just turning into orange), ripe (red) and over-ripe (deep red and soft). Mechanical drying was carried out in the Central Plantation Crops Research Institute (CPCRI) Small Holder's dryer. The dryer comprises of a drying chamber, plenum chamber, burning-cum-heat exchanger and chimney with regulators. Fresh spikes were spread on the wire-mesh surface of the drying chamber at a load density of 10 kgm^{-2}. Firewood was burned on the grate inside the burning chamber whenever required to keep burning. The drying air temperature was maintained at 60 – 65^{0}C by adjusting the exhaust valves as well as the fresh air inlet shutters at the bottom. As drying progressed, the weight loss of the material was recorded at hourly intervals. The material was again reloaded immediately to continue the drying. The time lapse during each weighing was subsequently adjusted in the drying time. Drying was continued till the weight reduction per unit time became insignificant and the drying ratio was computed. The drying curve was drawn by plotting moisture content against drying time and the drying equation was fitted using the SPSS statistical package.

The predicted moisture content values were calculated from the drying equation and the observed and predicted drying curves were compared.

Biochemical analyses were carried out on both fresh and dried chaba of different maturity stages. The parameters estimated were moisture content, volatile oil, oleoresin, piperine and starch. Moisture content was estimated by Dean and Stark method and expressed as $kgkg^{-1}$ DM (db). Volatile oil and oleoresin were estimated using American Spice Trade Association (ASTA, 1985) method while piperine was extracted and analyzed according to the procedure of Wood *et al.* (1988) using a Shimadzu Reversed-Phase HPLC. Starch was estimated by phenol-sulfuric acid method (as total carbohydrate multiplied by 0.9 factor) in a Shimadzu UV visible spectrophotometer at 499 nm. The samples in five replications per treatment were analysed. Data on quality of dried *chaba* were statistically analysed using SPSS package to find out the significant difference in quality among the three stages of maturity.

As the spikes ripen, due to physiological changes, the colour of the spikes turns from green to red and then into deep red colour with associated softening of the tissues. The proximate composition of fresh *P. chaba* at three stages of harvest is given in Table 1. The initial moisture content of mature, ripe and over-ripe spikes was 2.547, 2.404 and 2.374 $kgkg^{-1}$ DM, respectively. Moisture in the spikes decreased during ripening and was lower in ripe and over-ripe spikes compared to mature spikes.

Table 1. Proximate composition of fresh and dried *Piper chaba*

Maturity	Moisture kg^{-1} DM	Volatile oil %	Oleoresin %	Piperine %	Starch %
			Fresh		
Mature	2.547	0.40	3.83	0.85	16.23
Ripe	2.404	0.40	3.54	0.75	17.10
Over-ripe	2.374	0.37	3.26	0.72	17.47
			Dried		
Mature	0.059	1.29	8.09	2.19	50.09
Ripe	0.061	1.26	7.09	2.17	50.30
Over-ripe	0.069	1.06	6.59	1.99	50.52

When firewood is burnt, fresh air enters from the bottom and gets heated before moving up by natural convection. The drying temperature was maintained by adjusting the air inlet rate as well as the rate of combustion. The weight reduction observed at hourly intervals is presented in Table 2. At 60 to 65^{0}C, drying was achieved after 9 h of exposure. Fig. 1 shows the weight reduction observed during drying of chaba at the three stages. The weight reduction curve was similar for the three stages with the moisture loss per unit time being higher during the initial stages of drying, which decreased, as drying continued. More than 50 per cent of the total moisture was removed in the initial two hours of drying. The moisture content after 2 hours of drying was 1.230, 1.155 and 1.138 $kgkg^{-1}$ DM in mature, ripe and over-ripe spikes, respectively. The plot of drying rate Vs moisture content validates that chaba is dried in the falling rate period of drying. The dry recovery was highest in over-ripe stage (30.17 per cent) followed by ripe (30.12 per cent) and mature (29.43 per cent) stages. The drying ratio was computed as 3.375:1, 3.32:1 and 3.315:1 for mature, ripe and over-ripe spikes. Compared to ripe and over-ripe stages, the recovery in mature stage is lower owing to the higher initial moisture content and lower starch content.

Table 2. Hot air drying characteristics of *Piper chaba*

Maturity	Fresh weight (g)	Weight (g) at the end of 1st hr	2nd hr	3rd hr	4th hr	5th hr	6th hr	7th hr	8th hr	9th hr	Dry recovery %
Mature	5000	3893.25	3107.75	2553.75	2126.25	1856.50	1699.75	1594.50	1517.50	1471.25	29.43
Ripe	5000	3974.25	3165.75	2598.00	2173.50	1886.25	1738.75	1621.50	1548.75	1506.00	30.12
Over-ripe	5000	3959.75	3169.25	2584.50	2151.75	1877.25	1713.50	1610.00	1553.25	1508.25	30.17

Volatile oil, oleoresin and piperine were also higher in mature stage and showed a decreasing trend during ripening. The volatile oil and oleoresin content at mature, ripe and over-ripe stages were 0.40, 0.40 and 0.37 per cent and 3.83, 3.54 and 3.26 per cent. Piperine was estimated to be 0.85, 0.75 and 0.72 per cent while the starch content varied from 16.23 to 17.47 per cent in the three stages. The volatile oil, oleoresin and piperine were higher in mature spikes, which decrease during ripening. The reduction in volatile oil, oleoresin and piperine during ripening may be attributed to the physiological changes occurring in the spikes.

The drying curves obtained by plotting moisture content against drying time appear similar for all stages. Using regression analysis, the drying equation for chaba was best fitted as $y = a \times e^{bt}$

where,

y = moisture content (db) at any point of time

a, b = constants

t = drying time, min.

However, the values of a and b vary for the different stages. Table 3 gives the values of equation constants a and b as well as R^2 values of the model drying equation. The observed and predicted drying curves are shown in Figure 2a to 2c. In all maturity stages, the observed and predicted drying curves show high degree of comparability with the R^2 values lying in the range of 0.984 to 0.997. The accuracy of prediction was highest for mature spikes as seen from the R^2 value.

Table 3. Constants in drying equation of chaba

Maturity	a	b	R^2 value
Mature	2.8318	-0.0072	0.997
Ripe	3.0432	-0.0083	0.987
Over-ripe	3.1384	-0.0088	0.984

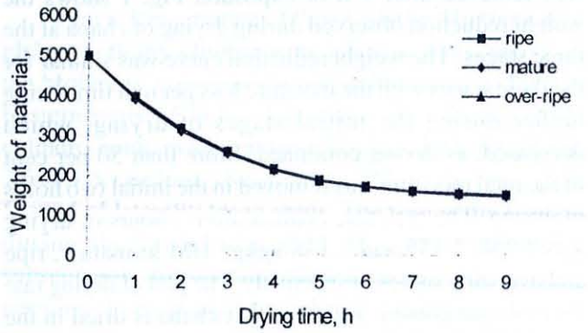

Fig. 1. Weight reduction curve of *Piper chaba*

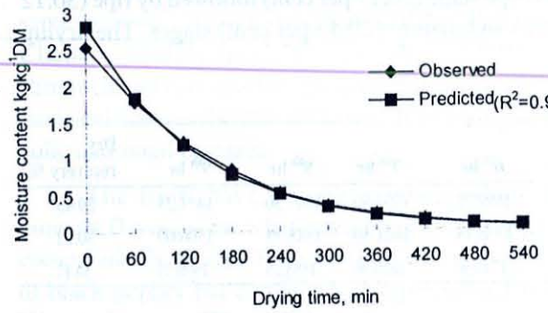

Fig. 2a. Drying curves of *Piper chaba* (mature)

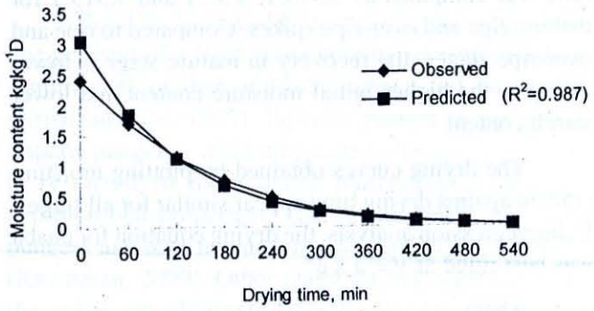

Fig. 2b. Drying curves of *Piper chaba* (ripe)

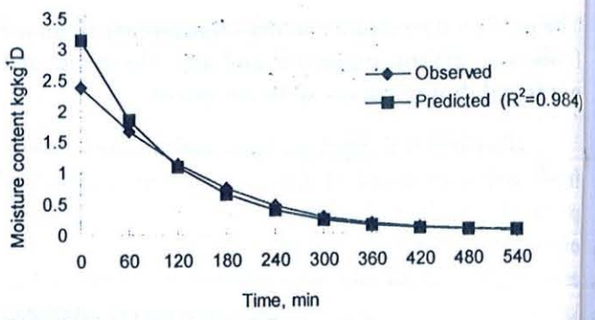

Fig. 2c. Drying curves of *Piper chaba* (over-ripe)

The quality of dried chaba is presented in Table 1. The moisture content after drying fell to 0.059, 0.061 and 0.069 $kgkg^{-1}$ DM in mature, ripe and over-ripe spikes respectively. However, the moisture content was not significantly different in the three stages. This moisture content was found to be safe for storage.

The volatile oil and oleoresin content in dried chaba were estimated as 1.29, 1.26 and 1.06 per cent and 8.09, 7.09 and 6.59 per cent respectively for mature, ripe and over-ripe stages. Due to loss of moisture by drying, the volatile oil and other constituents got concentrated and were higher compared to fresh chaba. Volatile oil, oleoresin and piperine content were higher in the mature spikes compared to the other stages. The volatile oil content is at significantly higher level (P <= 0.01) in the mature and ripe stages compared to over-ripe stage. However, there is no significant difference in the volatile oil content of ripe and mature spikes. Volatile oil contains the active principles and this is an important factor determining the quality. Oleoresin in dried chaba ranged from 6.59 to 8.09 per cent while piperine was found to vary from 1.99 per cent to 2.19 per cent. Though oleoresin and piperine were higher in mature stage, there does not exist any significant difference in these constituents with respect to maturity. The starch content of dried chaba ranged from 50.09 to 50.52 per cent. After drying, the colour of the mature, ripe and over-ripe spikes turned to black, brownish-red and black, respectively. Though, mature and ripe spikes have same quality, ripe spikes have poor market acceptability due to brownish-red colour. Mature spikes with black colour fetches the highest price. Therefore, it is concluded that chaba has to be harvested at the mature stage (greenish-orange) for maximum quality.

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