BIBLIOGRAPHY

DUGUIANG, JOEL A. MAY 2010. Postharvest and Processing Qualities of Chickpea (*Cicer arietinum* L.) Harvested at Different Maturity Indices Under La Trinidad, Benguet Condition , Benguet State University, La Trinidad Benguet.

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ABSTRACT

This study was conducted to; determine the postharvest and processing qualities of chickpea harvested at different maturity indices and identify the chickpea cultivar that has better postharvest and processing qualities when harvested at different maturity indices.

Results of the study showed significant differences between the variety and maturity index with regards to germination test, days from planting to harvesting, weight of 100 seeds, Dhal milling percentage, cookability of whole seeds and Dhal; and on the number of days from cooking to initial fungal development of Dhal and whole seeds.

Desi type variety ICCV 06102 harvested at yellow pod stage had significantly higher germination percentage, ICCV 953 34 harvested yellow green pod stage were significantly earlier to be harvested. The latest seed to show initial fungal development on cooked Dhal and whole seeds were harvested at yellow brown pod stage. On the sensory evaluation, ICCV92311 and 95334 harvested at yellow pod stage had the highest general acceptability in term of color, smell and texture. ICCV 07307 harvested at yellow brown pod stage had the highest weight of 100 seeds and the highest Dhal milling percentage. ICCV 93954 had the highest cookability rating for Dhal which were harvested at yellow green pod stage.

Based on the results, it is therefore recommended that for postharvest and processing is concerned, chickpea should be harvested at yellow pod stage and yellow brown pod stage and to grow the Kabuli type variety ICCV 92311 and ICCV 95334 for these varieties had the best sensory evaluation and latest fungal development. ICCV 07307 harvested at yellow brown pod stage is also recommended for higher milling (Dhal) percentage.

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INTRODUCTION

La Trinidad Valley is one of the thirteen Municipalities of Benguet, with sixteen barangays. It is the capital town and has the most population in the province.

Chickpea production in the locality has never been introduced. This plant can be described as "plants with stems that are branched, erect or spreading, sometime shrubby much branched, 0.2-1m tall, glandular pubescent, olive, dark, green or bluish green in color. Root system is robust, up to 2 m deep, but major portion up to 60 cm leaves inparipunnate, glandular-pubescent with 3-8 pairs of leaf lets, margin serrate, apex acuminate to aristate, base cuneate. Flower solitary, sometimes 2 per inflorescence, corolla white, pink purplish, blue .2 cm long. The staminal column is diadelphous and the ovary sessile, inflated and pubescent "(Duke, 1981; Cubero 987, Vander Maesen, 1987). Pod rhomboid ellipsoid, 1 to 2with 3 seed as a maximum, and inflated, glandular-pubescent. Seed color cream, yellow, brown, block, or gray, rounded to angular, seed coat smooth or wrinkled, or tuberculated lateral compressed with a median groove around 2/3 of the seed anterior bend; germination cryptocotylar.

Chickpea is the one of the most important legumes. It is the good source of folate, rich in protein and high in dietary fiber, thus an excellent of healthy food. The name chickpea was derived ultimately from the Latin name *cicer* through the French *chiche*. *Garbanzo* bean which is also another term for chickpea came from the Spanish language Vander Maesen (1972) believes that the species originated in the southern Caucus and Northern Persia. However, Ladizinsky (1975) reported the center of origin to be the southern Turkey." botanical and archeological evidence show that chickpeas where first domesticated in the Middle east and where widely cultivated in India, Mediterranean

area, the Middle East and Ethiopia since antiquity. Brought to the new world, it is now important in Mexico, Argentina, Chile, Peru, and the US, also imported in Australia. The species are mort abundant in Turkey, Iran, Afghanistan, and Central Asia" (Duke, 1981). India contributes 75% of the total world population of chickpea followed by turkey and Pakistan (Singh *et al*., 1987).

The result of the study will serve as a guide to perspective growers, producers, and propagators of chickpea and could also help to enhance their knowledge, skills and understanding regarding chickpea production and postharvest characteristic. By doing so, this will encourage them to discover new farming systems or procedure that can be further modified for better production. These will also become good endeavors on the parts of the farmers in promoting and giving utmost importance to recent innovation and technologies in the production will eventually an income generating activity and a way to maximize the yield per area ventures or enterprise for the farmers. Likewise, this study will also serve as a guide and reference for the researchers for further conduct of researches and studies pertaining chickpea production and postharvest characteristics in our locality.

The objectives of the study were to determine the postharvest and processing qualities of chickpea harvested at different maturity indices and to identify the chickpea cultivar that has better postharvest and processing qualities when harvested at different maturity indices.

This study was conducted at the Balili Experimental Station of the Benguet State University, La Trinidad, Benguet from November 2009 to March 2010.

REVIEW OF LITERATURE

Description of Chickpea

Chickpea (*Cicer arietinum* L.) is grown in tropical, sub-tropic and temperate regions. It is self-pollinatedcrop, cross-pollination is rare: only 0-1% is reported (Singh, 1987; Smithson et.al., 1985). Grown usually as a rain fed and it is a cool weather crop and a dry climate crop in semi-arid regions. Optimum conditions include 18-26 degree Celsius day and 21-229 degree Celsius night temperate and annual rainfall of 600-1000 mm. it is a small bushy annual plant. It is approximately grown at about 1-2ft (30-60cm.) tall. The root system is well developed and usually include central strong tap root with numerous lateral branches that spreads out in all directions at the upper layer of the soil. The stem is generally grayish in appearance and is branched with one terminal leaflet. However, the number as well as the size of leaflet varies in different sizes. The leaflets of pinnate leaves are small and have serrated edges. The leaves also vary in colors; some ate green while others are dark or green. Certain type possesses leaflets with red margins (Singh, 1987).

Further, the flowers are typical pappilionaceous consisting of five petals and sepals of the standard; the pod is about 2 cm long and usually contains two seeds. A single plant produces about 50to 150 pods. Seeds are spherical in shape, wrinkled and with pointed beak. The seed vary in size as well as in color which vary from white, light brown, yellowish orange, brown, dark brownish and with a little bluish tinge. The seed coat may be smooth or puckered or wrinkled. The cotyledons are thick and yellowish in color (Singh, 1987).

Importance and Uses of Chickpea

Chickpea is valued for its nutritive seeds with high protein content, 25.3-28.9%, after dehulling (Hulse, 1991). Chickpea seeds are eaten fresh as green vegetables, parched, fried, roasted, and boiled; as snack food, sweet and condiments; seeds are ground and the flour can be used as soup, dhal, and to make bread; prepared with pepper salt and lemon it is serve as a side dish (Saxena, 1990). Dhal is the split chickpea without its seed coat, dried and cooked into thick soup or ground into flour for snack and sweetmeats. 'Sprouted seeds are eaten as vegetable or added to salads young plants and green pods are eaten like spinach. An animal feed is another use of chickpeas in many suitable for plywood. Gran husk, and green or dried stems and leaves are used for stock feed; whole seed may be milled directly for feed. Leaves are said o yield an indigo like dye. In Chile, a cooked chickpea-milk (4:1) mixture was a good for feeding infants, effectively controlling diarrhea. Chickpeas yield 21% starch suitable for textile sizing, giving a light finish to silk, wool and cotton cloth" (Duke, 198).

Medicinal applications include use of aphrodisiac, bronchitis, catarrh, cutamenia, cholera, constipation, diarrhea, dyspepsia, flatulence, snake bit, Sunstroke, and warts. Acids are supposed to lower the blood cholesterol levels. Seeds are considered antibilous (Duke, 1981).

Climatic Requirements

Chickpea can thrive on a sunny site in cool, dry climate on well-drained soils and grows on residual moisture in the post-rainy seasons of sub-tropical winter or spring of Northern Hemisphere. "Generally chickpea can grow on heavy black soil or red soils with PH of 5.5-8.6 frost hailstones or under snow cover". Daily temperature fluctuations

are desired with cold night with dew fall. Relative humidity of 21-41% is optimum for seed setting. In virgin sandy soil as for the first planting in heavier soils, inoculation is said to increased yield by 10.62%. Although spoken as “day-neutral”, chickpea is a quantitative long day pants, but flowers in every photoperiod (Smithson *et al.*, 1985)

Proper Maturity Stage.

Good quality in fruits and vegetable are obtain when harvesting is done at the proper stage of maturity (Pantastico, 1975). On the other hand, delayed harvest of fruits and vegetables may increase their susceptibility to decay which results in poor quality and hence low market value. Harvesting at the proper stage of harvesting will do much to slow down the deterioration of quality (Bautista, 1990). It is found that commodity harvested before the optimum stage of maturity has a poor quality which leads to early deterioration. On the contrary, when commodity is harvested beyond the optimum maturity, stage life is shortened.

Harvesting and Threshing

Chickpea mature 3-7 months and the leaves turn brown/yellow during maturity. For dry seeds, the plants are harvested at maturity (Pantastico, 1975). On the other hand, delayed harvest of fruits and vegetables may increase their susceptibility to decay which results in poor quality and hence low market value. Harvesting at the proper stage of harvesting will do much to slow down the deterioration of quality (Bautista, 1990). It is found that commodity harvested before the optimum stage of maturity has a poor quality which leads to early deterioration. On the contrary, when commodity is harvested beyond the optimum maturity, stage life is shortened.

Chickpea mature 3-7 months and the leaves turn brown/yellow during maturity. For dry seeds, the plants are harvested at maturity or slightly earlier by cutting them close to the ground or uprooting. The plant is staked in the field for a few days to dry and the crop is threshed by trampling or beating with wood flails. The chaff is separated from the grain by winnowing. Tall cultivars are suitable for mechanized harvesting in which case combines can be used. Chickpeas are usually stored in bags, but are more subject to insect damage then when stored in bulk. Proper cleaning, drying and aeration are necessary to control seed beetles. A thin coating with vegetables oil can reduce storage containers. Threshing is done either by beating the plant with stick or by trampling under two feet bullocks.

Drying and Storage

Moisture content should be around 10-12% to prevent insect and other diseases outbreaks in the storage. Because of their relative large seed sized, chickpea can be dried slightly with ambient temperature and these through thin layers in a regular storage bin. Storage system should be carefully fumigated before storing chickpea and all storage area should be regularly monitored to identify potential problems early.

Postharvest Handling and Storage

Storage is an important operation in the marketing of crops. It regulates the supply and demand of produce. According to Ware (1970). Loss from rot or decay is entire different from physiological shrinking and it is after much more serious from the economic stand point. It has been observed that the postharvest handling losses are much greater than losses due to weeds and diseases (Pantastico, 1975). Losses due to improper

postharvest handling and storage of crop are high as 30-40%. When harvesting is not handled properly, quality is decrease.

Landacan (1992), stated that postharvest losses can go as high as 50% due to the fallowing factors; cultivar, storage of flower development at harvest, pre-harvest environment practice imposed on the crop handling and transport losses of the crop occur during peak of production where production fail to synchronized peak demands coupled with depressed market quality.

MATERIALS AND METHODS

Materials

The materials used in the study are seeds of chickpea, pesticides, weighing scale, watering cans, Japanese hoe, farm tools, and other equipments.

Methods

The study was laid out in a randomized complete block design (RCBD) in factorial arrangement with variety as factor A and maturity index as factor B. There were three replications with three sample plants per treatment. The seeds were sown at 30 cm. between rows and 20 cm between hills. Hilling-up operation was done one month from planting. The treatments were as follows;

Factor A (Type of Cultivar)

'DESI Type	'KABULI' Type
V1-ICCV93952	V4-ICCV92311
V2-ICCV93954	V5-ICCV95334
V3-ICCV06102	V6-ICCV07307

Factor B (Harvest Index)

P1 – Yellow green pod stage

P2 – yellow pod stage

P3 – yellow brown pod stage (from ICRISAT)

Data Gathered

1. Germination test (%). This was taken one month from storage through Petri dish method. this was computed using the formula;

$$\text{Emergence Percentage (\%)} = \frac{\text{Number of Seed Germinated}}{\text{Number of Seed Sown}} \times 100$$

2. Days from planting to harvesting. This was taken when 50% of the pods have been harvested.

3. Weight of 100 seeds (grams). This was taken at 14% moisture content by weighing the 100 seeds.

4. Dhal milling percentage (%). This was taken after milling by weighing the Dhal seeds (dehusked split peas).

5. Cookability of dhal seeds. Increase in volume (v/v) after soaking in water for 24 hours and boiling for 25 minutes.

6. Days from milling to initial rotting (fungal development). This was the number of days from milling to initial fungal development under ambient condition.

7. Days from cooking to initial fungal development. This was the number of days from cooking to initial fungal development under ambient condition.

8. Cookability of dry seeds. Increase in volume (v/v) after soaking for 24 hours in water and boiling for 25 minutes.

9. Sensory evaluation. A panel of 20 students and teachers were organized to taste the cooked dhal and whole grain. The rating scales were the following;

Scale	Description
1	Like very much
2	Like moderately
3	Neither like nor dislike
4	Dislike moderately
5	Dislike very much

10. Photo documentation. This was taken through pictures during planting, harvesting, and processing and during taste test. (Figures 1 to 7)

Figure 1. Overview of the experiment during the vegetative stage

Figure 2. Overview of the experiment at maturity stage

Figuer 3. Harvesting stage

Figure 4. Overview of Dhal and whole grain seeds before the sensory evaluation was conducted

Figure 5. Fungal development of both dhal and whole grain seeds, 3 days from cooking

Figure 6. Pictures taken during the sensory evaluation of panelist and evaluators

Figure 7. Seed germination test preparation at the laboratory

11. Meteorological data. Temperature, Relative Humidity, and Rainfall. This was records during the cropping season and to be taken at the BSU-PAGASA office.

Meteorological Data

Figure 8 shows the meteorological data, from November 2009 to March 2010, taken from BSU- PAGASA station during the duration of the study. The temperature ranged from 21.05°C on the month of December to 22.95°C on the month of February. The month of November recorded a temperature of 22.2°C, month of February with 22.6°C and in the month of March with a temperature of 22.9°C.

The relative humidity recorded during the conduct of the study ranged from 82.75% on December to 88% on the month of January. The month of November had a relative humidity of 84%, month of February with 84.5% and month of March with a relative humidity of 86.75%.

There was no recorded rainfall during the duration of the study.

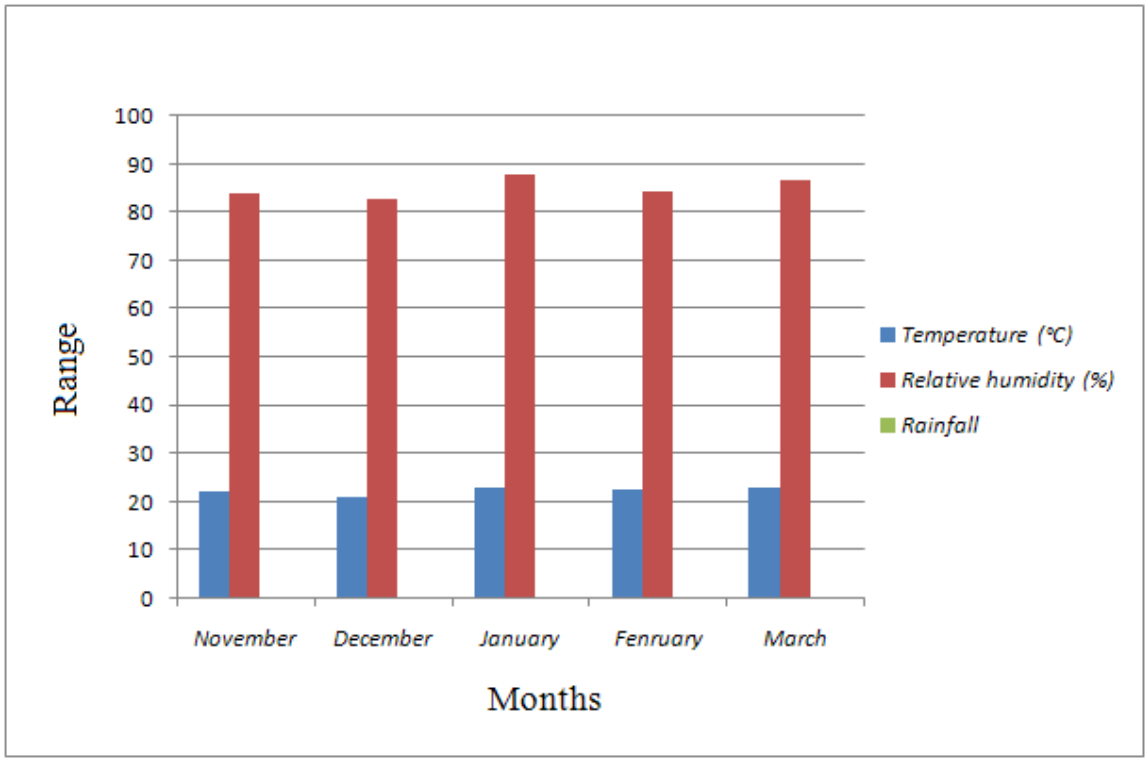

Figure 8. Meteorological data, from November 2009 to March 2010, taken from BSU-PAGASA Station

RESULTS AND DISCUSSION

Germination Test (%)

Effect of variety. Table 1 show the germination percentage through Petri dish method results shows that there were significant differences among the varieties tested. Desi type variety ICCV 06102 had obtained the highest germination percentage followed by ICCV 93952 with a mean of 94.67% and 94.44% respectively. ICCV 07307 a Kabuli type variety attained the lowest germination percentage with a mean of 63.56% that was

Table 1. Germination test (%)

TREATMENT	MEAN (%)
Variety	
ICCV 93952	94.44[a]
ICCV 93954	93.11[a]
ICCV 06102	94.67[a]
ICCV 92311	94.67[b]
ICCV 95334	70.22[c]
ICCV 07307	63.56[c]
Maturity index	
Yellow green pod stage	77.68[c]
Yellow pod stage	89.33[a]
Yellow brown pod stage	83.89[b]
CV%	9.08

Means with a common letter are not significantly different at 5% by DMRT.

the same with the emergence percentage done in the field. Germination test was done in seeds with 14% moisture content.

Effect of maturity index. The effect of maturity index showed significant differences on the germination test. Chickpea seeds harvested at yellow pod stage had the highest germination percentage with a mean of 89.33%. While chickpea variety ICCV 07307 harvested at yellow green pod stage had the lowest germination percentage with a mean of 63.56%.

Interaction effect. Statistical analysis revealed that there were significant differences observed between the two factors; variety and maturity index. Variety ICCV 06102 harvested at yellow pod stage attained the highest germination percentage with a mean of 94.67 percent; while ICCV 07307 harvested at yellow green pod stage had the lowest germination percentage with a mean of 63.56 percent (Figure 9).

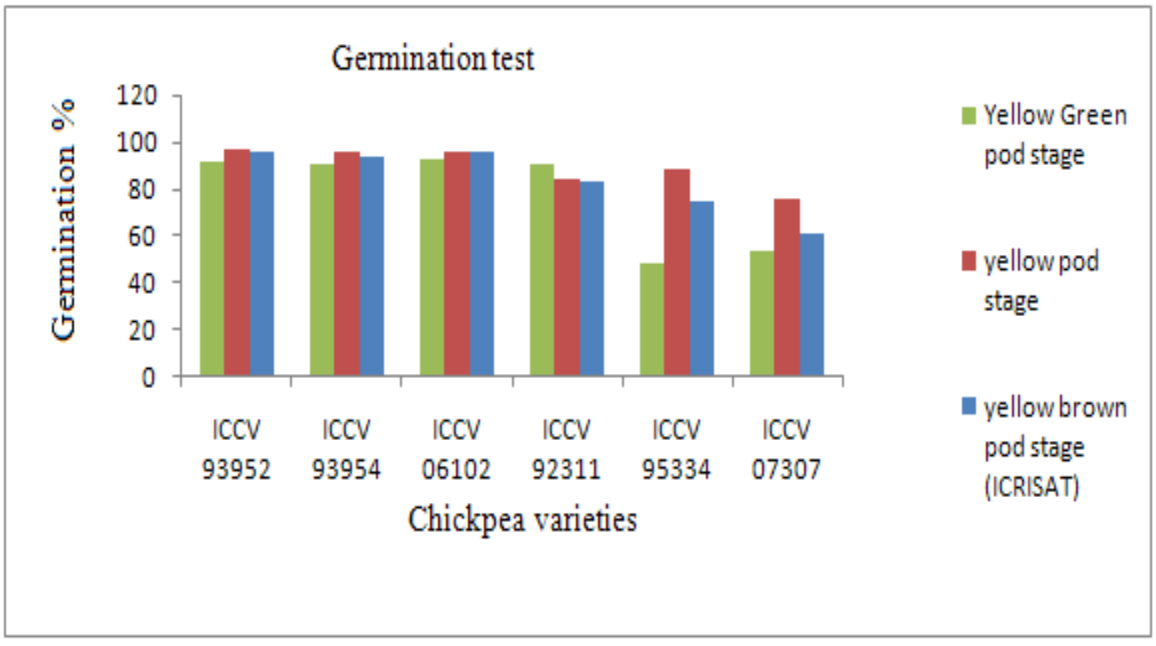

Figure 9. Germination test

Days From Planting to Harvesting

Effect of variety. Table 2 shows that number of days from planting to harvesting was not significantly affected by the varieties used. However Kabuli varieties ICCV 95334 were harvested earlier followed by Desi variety ICCV 93952 with a mean of 126 days and 126.56 days respectively. Kabuli variety ICCV 07307 and Desi ICCV 93954 were the latest to reach harvesting stage.

Table 2. Days from planting to harvesting

TREATMENT	DAYS
Variety	
ICCV 93952	126.56[a]
ICCV 93954	128.54[a]
ICCV 06102	126.67[a]
ICCV 92311	126.67[a]
ICCV 95334	126.00[a]
ICCV 07307	128.44[a]
Maturity index	
Yellow green pod stage	118.11[c]
Yellow pod stage	128.39[b]
Yellow brown pod stage	134.89[a]
CV%	2.47

Means with a common letter are not significantly different at 5% by DMRT

Effect of maturity index. There were significant effects noted on the maturity index of pods as to the days from planting to harvesting. Chickpea harvested at yellow green pod stage were the earliest to be harvested with those harvested at yellow brown pod stage were harvested the latest.

Interaction effect. There were significant interaction effects noted between the variety and maturity index on the days from planting to harvesting. ICCV 9533 harvested at yellow green pod stage were the earliest to be harvested with those harvested after 118 day, while ICCV 07307 harvested at yellow brown pod stages (from ICRISAT) were the latest to be harvested with a mean of 134.89 days.

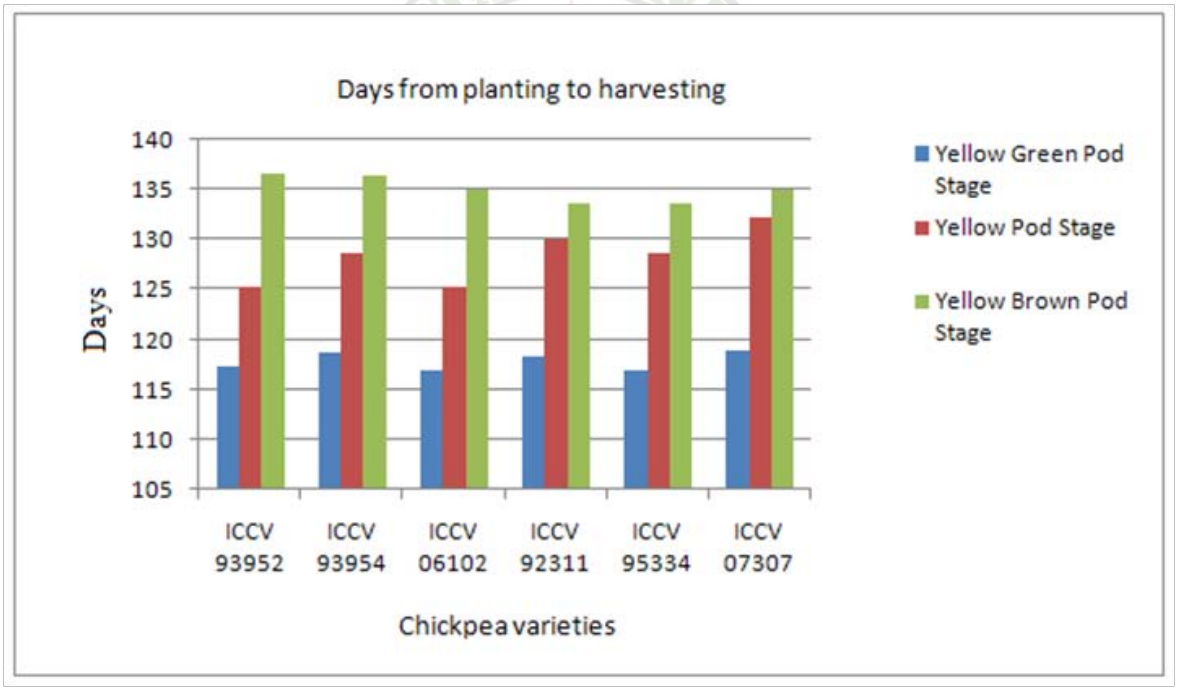

Figure 10. Days from planting to harvesting

Weight of 100 Seeds

Effect of variety. Table 3 shows the weight of 100 seeds in grams as affected by variety used. Large seeded Kabuli type ICCV 07307 had significantly higher weight with 34.60g/ 100 seeds, while small seeded Desi variety ICCV 93954 had the lowest weight with seed weight of 25.69g per 100 seeds.

Thus, the result indicates that seed weight depends on the seed size. The bigger the seed, the heavier the weight and the smaller it is, the lower the weight.

Table 3. Weight of 100 seeds

TREATMENT	WEIGHT (g)
Variety	
ICCV 93952	27.46[c]
ICCV 93954	25.69[d]
ICCV 06102	27.62[c]
ICCV 92311	31.39[b]
ICCV 95334	33.83[a]
ICCV 07307	34.60[a]
Maturity index	
Yellow green pod stage	30.06[a]
Yellow pod stage	30.04[a]
Yellow brown pod stage	30.19[a]
CV%	2.47

Means with a common letter are not significantly different at 5% by DMRT

Moreover, Muehbaver and Singh 1987, Poniedziaklek *et.al*. 1996 said that in Poland, minimum Kabuli type seed weight (100) is about 495g especially to the large seeded Kabuli chickpea, whereas Desi type, a small seeded has a minimum weight of 245g per 1000 seeds, cited by Poniedzialeh, 2005.

Effect of maturity index. Results show that there were no significant differences observed on the weight of 100 seeds (gram) as affected by maturity index. However Chickpea seeds harvested at yellow brown pod stage (from ICRISAT) had the heaviest seed weight of 30.19g while chickpea harvested at yellow green pod stage and yellow pod stage had comparable means of 30.06g and 30.06g respectively.

Interaction effect. There were significant interaction effects noted between the variety and maturity index on the weight of 100 seeds. ICCV 07307 a big seeded Kabuli type harvested at yellow brown pod stage produced the heaviest weight of 100 seeds with a mean of 34.60 grams while ICCV 93954 harvested at yellow pod stage obtained the lowest weight of 25.69 grams for 100 seeds (Figure 11).

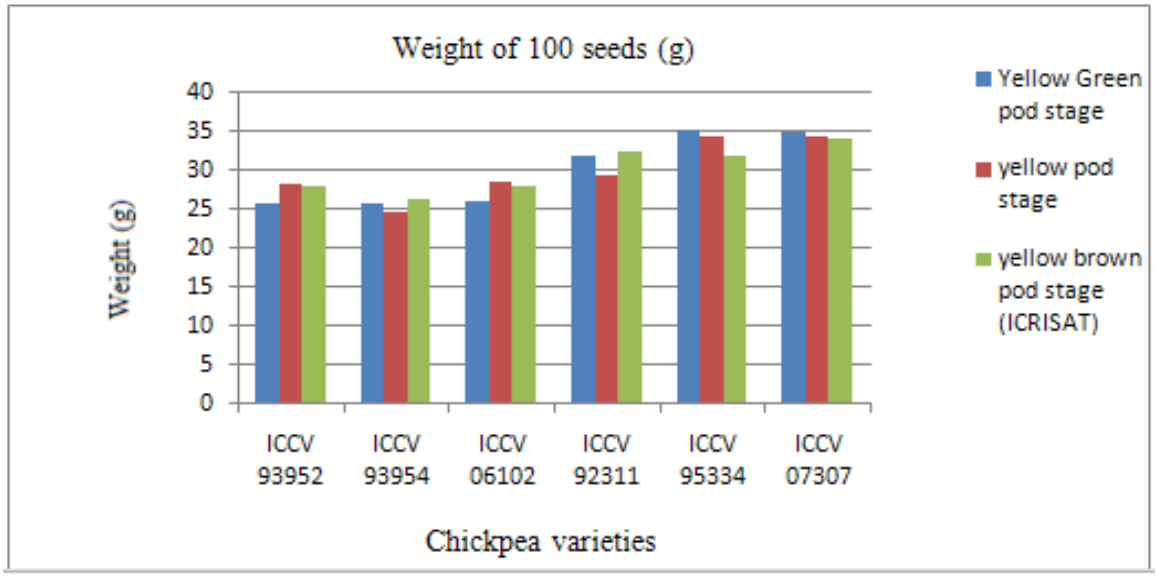

Figure 11. Weight of 100 seeds (g)

Dhal Milling Percentage

Effect of variety. The Dhal milling percentage (Table 4) was significantly affected by the different varietiea used. Large seeded Kabuli type variety ICCV 07307 with higher weight, and thinner seed coat had significantly higher Dhal milling percentage with a mean of 90.64%. Desi type varieties on the other hand, had smaller seeds, lesser weight, and thicker seed coat, had the lowest Dhal milling percentage with ICCV 93952 having the lowest with a mean of 81.74%.

Table 4. Dhal milling percentage

TREATMENT	WEIGHT (%)
Variety	
ICCV 93952	81.74[c]
ICCV 93954	81.94[c]
ICCV 06102	82.60[c]
ICCV 92311	89.30[b]
ICCV 95334	89.59[ab]
ICCV 07307	90.64[a]
Maturity index	
Yellow green pod stage	85.28[b]
Yellow pod stage	86.04[ab]
Yellow brown pod stage	86.58[a]
CV%	1.50

Means with a common letter are not significantly different at 5% by DMRT

Effect of maturity index. Results show that there were significant differences on the Dhal milling percentage as affected by maturity. Chickpea seeds harvested at yellow brown pod stage (from ICRISAT) significantly the highest Dhal milling percentage with a mean of 86.58%, while chickpea seeds harvested at yellow green pod stage had the lowest Dhal milling percentage with a mean of 85.28%.

Interaction effect. There were significant interaction effects observed between variety and maturity index with regards on the Dhal milling percentage. ICCV 07307 harvested at yellow brown pod stage had significantly higher Dhal milling percentage with a mean of 90.64%, while chickpea seeds from ICCV 93952 harvested at yellow green pod stage had the lowest Dhal milling percentage with a mean of 81.74% (Figure 12).

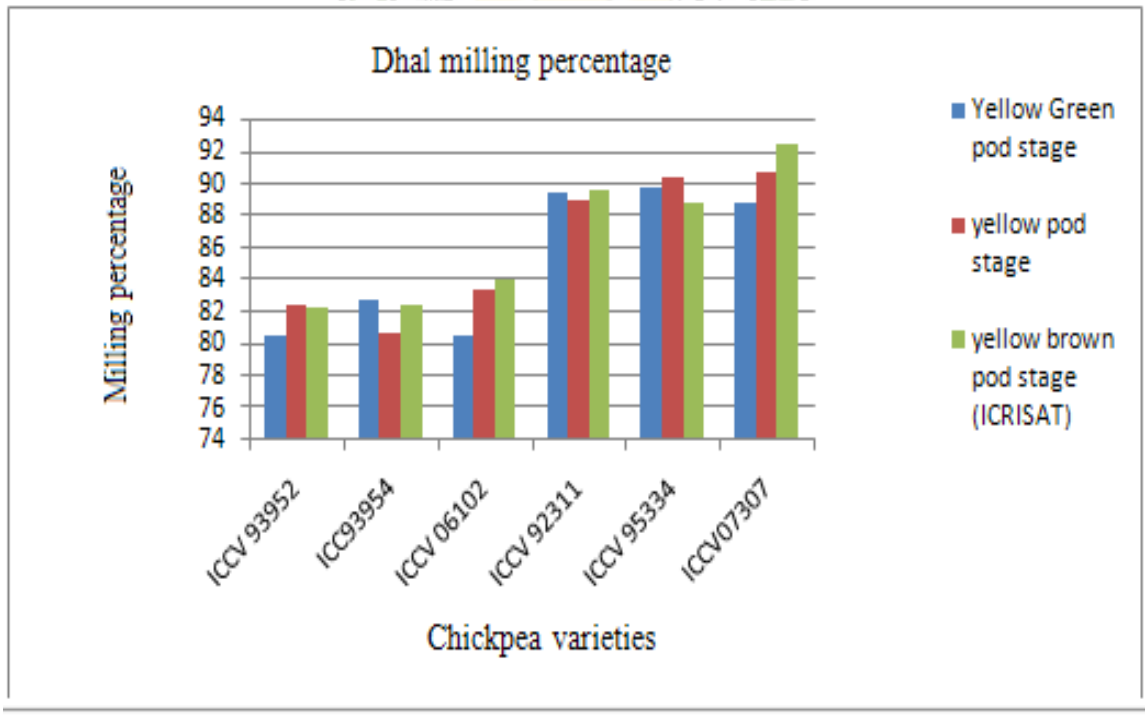

Figure 12. Dhal milling percentage

Cookability of Whole Seeds

Effect of variety. Table 5 shows significant statistical differences among the varieties on the cookabilty of the whole seeds. Chickpea seeds weighing 100 grams were soaked in 200 grams water for about 24 hours overnight then measured for the increased in volume and boiled for 25 minutes then measured again for the increased in volume. A Kabuli variety which has bigger seeds was significantly higher increased in volume. ICCV 95334 had the highest with a mean of 106.22% by volume while Desi type ICCV 06102 had the lowest increased by volume with a mean of 101.67%.

Table 5. Cookability of whole grain seeds

TREATMENT	MEAN(v/v)
Variety	
ICCV 93952	105.78[a]
ICCV 93954	106.00[a]
ICCV 06102	11.67[b]
ICCV 92311	103.44[ab]
ICCV 95334	106.22[a]
ICCV 07307	103.78[ab]
Maturity index	
Yellow green pod stage	105.83[a]
Yellow pod stage	105.44[a]
Yellow brown pod stage	102.17[b]
CV%	3.14

Means with a common letter are not significantly different at 5% by DMRT

Effect of maturity index. Cookability of dry seeds was significantly affected by maturity index used as shown in table 5. Chickpea seed harvested at yellow green pod stage had the highest increased by volume with a mean of 105.83 compared with chickpea harvested at yellow brown pod stage (from ICRISAT) which had the lowest increased by volume with a mean of 102.17%.

Interaction effect. Significant differences were observed on the cookability of the whole seeds as affected by variety and maturity index. Variety ICCV 95934 harvested at yellow green pod stage had the highest increased in volume or cookability while ICCV 06102 harvested at yellow brown pod stage had the lowest cookability percentage (Figure 13)

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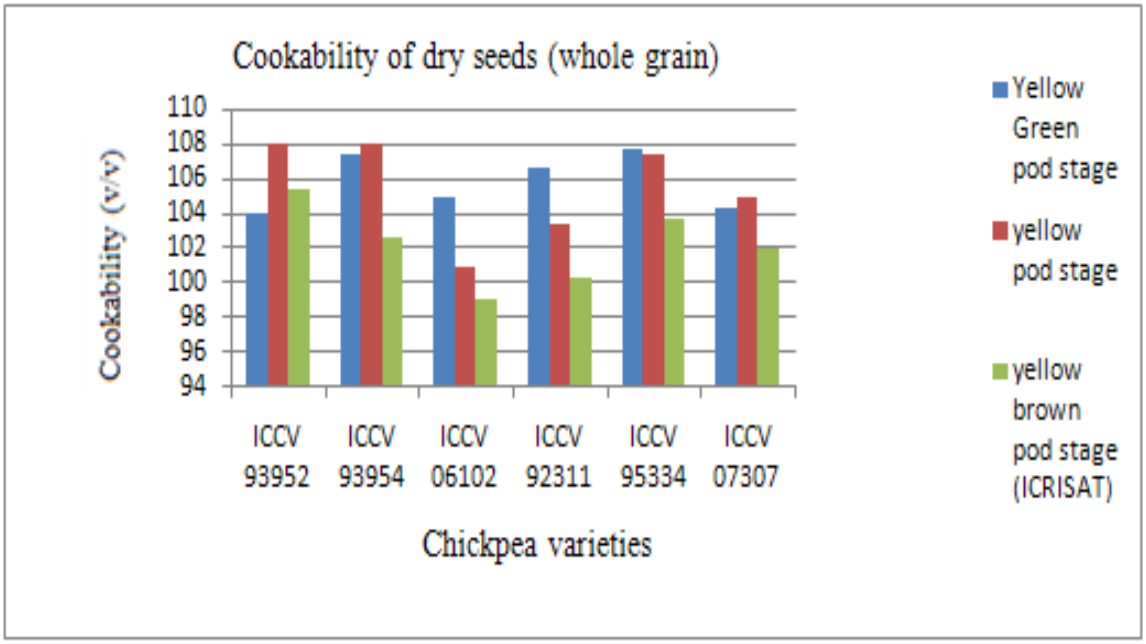

Figure 13. Cookability of whole seeds

Cookability of Dhal

Effect of variety. The cookability of Dhal was presented in Table 6. Result shows that there were significant differences among the varieties of chickpea studied. ICCV 93954 a Desi type variety had the highest cookability of the Dhal with a mean of 100% increased by volume; while ICCV 07307 a Kabuli type variety had the lowest cookability of Dhal with a mean of 95.33% increased by volume.

Table 6. Cookability of dhal seeds

TREATMENT	MEAN(v/v)
Variety	
ICCV 93952	99[ab]
ICCV 93954	100[a]
ICCV 06102	99.11[ab]
ICCV 92311	98.11[b]
ICCV 95334	99.33[ab]
ICCV 07307	95.33[c]
Maturity index	
Yellow green pod stage	98.89[a]
Yellow pod stage	98.56[a]
Yellow brown pod stage	98.00[a]
CV%	1.72

Means with a common letter are not significantly different at 5% by DMRT

Effect of maturity index. There were no significant differences noted for cookability of Dhal as affected by maturity index. However, Chickpea harvested at yellow green pod stage had higher cookability of Dhal with a mean of 98.89% while Dhal harvested at yellow brown pod stage had the lowest cookability with a mean of 98% increased by volume.

Interaction effect. There were significant interaction effect noted between the variety and maturity index on the cookability of the Dhal seeds. ICCV 93954 a Desi variety harvested at yellow green pod stage obtained the highest cookability of the Dhal with a mean of 100% increased by volume, while ICCV 92311 a Kabuli type, on the other hand harvested at yellow brown pod stage (from ICRISAT) had the lowest cookability of Dhal with a mean of 98.11% increased by volume (Figure 14)

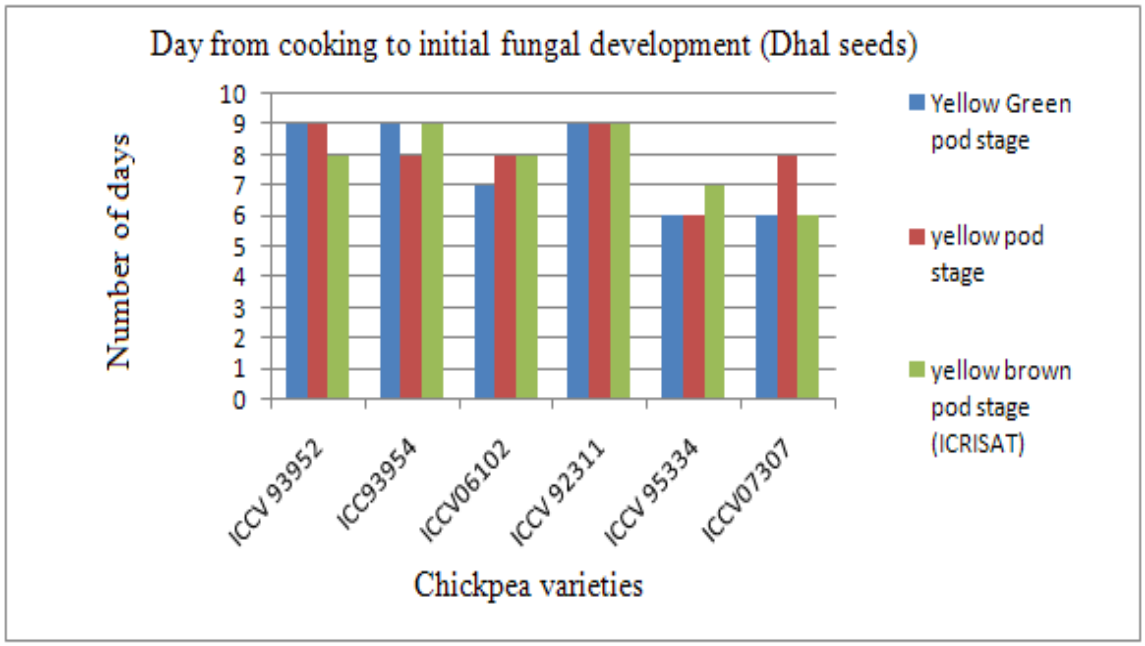

Figure 14. Days from cooking to initial fungal development (Dhal)

Days from Cooking to Initial Fungal Development (whole grain)

Effect of variety. Table 7a shows that there were significant differences among the varieties of chickpea grown on the days from cooking to initial fungal development. ICCV 95334 a Kabuli type variety were the latest to show initial fungal development with a mean of 3 days under ambient condition; while Desi type ICCV 93952 were the earliest to show initial fungal development with a mean of 2.33 days.

Table 7a. Days from cooking to initial fungal development (whole grain)

TREATMENT	DAYS
Variety	
ICCV 93952	2.33[b]
ICCV 93954	2.67[ab]
ICCV 06102	2.89[a]
ICCV 92311	2.89[a]
ICCV 95334	3.00[c]
ICCV 07307	2.44[c]
Maturity index	
Yellow green pod stage	2.61[b]
Yellow pod stage	2.56[a]
Yellow brown pod stage	2.94[a]
CV%	11.23

Means with a common letter are not significantly different at 5% by DMRT

Effect of maturity index. The effect of maturity index on the days from cooking to initial fungal development was significant. Chickpea seeds harvested at yellow green pod stage were the earliest to have initial fungal development, while chickpea seeds that were harvested at yellow brown pod stage were the latest to initiate fungal development with a mean of 2.94 days.

Interaction effect. There were no significant interaction effects of variety and maturity index on the number of days from cooking to initial fungal development of whole grain chickpea seeds.

Days from Cooking Dhal to Initial Fungal Development

Effect of variety. Table 7b shows that there were significant differences on the days from cooking dhal to initial fungal development as affected by variety. Cooked seeds of ICCV a 95334 Kabuli type variety were the earliest to initiate fungal development with a mean of 2.11 days, while cooked seeds of ICCV 92311 also a Kabuli type were the latest to initiate fungal development on cooked dhal with a mean of 3 days.

Bayugan and Salda (1985) reported that decay, shriveling and discoloration are condition that developed during storage which influences the general appearance of the commodity.

Effect of maturity index. The difference in the number of days from dhal cooking to initial fungal development as affected by maturity index was not significant. However, chickpea seeds harvested at yellow green pod stage were the earliest to initiate fungal development after 2.56 days.

Interaction effect. There were significant differences on the days from cooking to initial fungal development as affected by variety and maturity index. ICCV 95334 a

Kabuli type were harvested at yellow green pod stage were the earliest to initiate initial fungal development on cooked dhal of 2.11 days, while ICCV 92311 also a Kabuli type chickpe harvested at yellow brown pod stage and yellow pod stage were the latest to show initial fungal development on cooked dhal of 3 days respectively (Figure 14).

Table 7b. Days from cooking to initial fungal development (Dhal)

TREATMENT	DAYS
Variety	
ICCV 93952	2.89[ab]
ICCV 93954	2.89[ab]
ICCV 06102	2.67[b]
ICCV 92311	3.00[a]
ICCV 95334	2.11[c]
ICCV 07307	2.22[c]
Maturity index	
Yellow green pod stage	2.56[a]
Yellow pod stage	2.67[a]
Yellow brown pod stage	2.67[b]
CV%	11.23

Means with a common letter are not significantly different at 5% by DMRT

Sensory Evaluation (Whole Grain)

Color. Concerning the color of the prepared cooked chickpea seeds, out of 20 student and teachers panel evaluators, 65% of them 'like very much' the color of Kabuli

variety ICCV 92311 and ICCV 95334 which were both harvested at yellow pod stage. While 35% of the evaluators stated that they 'neither like nor dislike' the color of Desi variety ICCV 06102 which were both harvested at yellow green pod stage.

Smell. As to the smell, evaluators 'like very much' the smell of the Kabuli variety ICCV 95334 and ICCV 07307. However, 35% of the 20 evaluators stated that they 'dislike moderately' the smell of Desi variety ICCV 95334 which was harvested at yellow brown pod stage.

Texture. On the texture of the cook chickpea seeds, 65% of the evaluators 'like very much' the texture of Kabuli variety ICCV 95334 which was harvested at yellow pod stage. ICCV 07307 also a Kabuli type variety harvested at yellow green pod stage and yellow brown pod stage 40% of the evaluators said that they neither like nor 'dislike' the texture.

Taste. Prepared cooked chickpeas seeds (whole grain) were tasted by 20 panels of student and teachers. Chickpea seeds were soaked in water for 24 hours overnight and cooked for 25 minutes without salt then put in a plastic cup when cooked. Out of 20 evaluators 75% of them 'like very much' the taste of the Kabuli variety ICCV 92311and ICCV 95334 which were both harvested at yellow pod stage. While Desi variety ICCV 93954 harvested at yellow green pod stage, 40% of the evaluators were tasted it as 'dislike moderately'.

General acceptability. Concerning the general acceptability of the cooked chickpea seeds. Results showed that chickpea variety ICCV 92311 and ICCV 95334 which were both harvested at yellow pod stage obtained the highest acceptability rating as perceived by the evaluators and that they 'like very much', While Desi variety ICCV

93954 and ICCV 06102 had lower acceptability rating of 'dislike moderately' by the evaluators.

Sensory Evaluation of Cooked Dhal

Color. Generally, the majority of the evaluators 'like the color' of the Desi and Kabuli type cooked dhal, Kabuli ICCV 92311 and ICCV 95334 were judged as 'like very much' in terms of color by the evaluators and these were both harvested at yellow pod stage. While 60% of 20 evaluators judged as dislike moderately Desi variety ICCV 9395 4 harvested at yellow green pod stage.

Smell. On the smell of cooked Dhal chickpea seeds, Kabuli ICCV 07307 harvested at yellow green pod stage were 70% of the evaluators judged that they 'dislike very much' the smell. While Desi varieties ICCV 93952 harvested at yellow pod stage were judged 'like very much' by the evaluators.

Texture. On the texture of the cooked chickpea seeds 55% of the evaluators 'like very much' the texture of Kabuli variety ICCV 92311 which was harvested at yellow pod stage, while 70% of the evaluators 'dislike moderately' the texture of ICCV 07307 also a Kabuli variety harvested at yellow green pod stage and yellow brown pod stage.

Taste. Concerning the taste of the Dhal cooked chickpea the majority of the evaluators like the taste. However Kabuli variety ICCV 95334 and ICCV 92311 were judged as 'like very much' by the evaluators and these were both harvested at yellow pod stage. While Desi variety ICCV 93954 and ICCV 06102 were both judged as 50% of the evaluators were 'dislike moderately' the taste and these were both harvested at yellow green pod stage.

Table 8a. Sensory evaluation (whole grain)

		COLOR	SMELL	TEXTURE	TASTE	ACCEPTABILITY
1	P_1	2	3	2	2	2
	P_2	2	3	2	2	2
	P_3	2	3	2	2	2
V_2	P_1	2	4	2	4	4
	p_2	2	3	2	2	2
	P_3	2	3	2	2	2
V_3	P_1	3	3	2	3	4
	P_2	2	2	2	2	2
	P_3	2	2	2	2	2
V_4	P_1	2	2	2	2	2
	P_2	1	2	2	2	1
	P_3	2	2	2	2	2
V_5	P_1	2	2	2	2	2
	P_2	1	1	1	1	1
	P_3	2	2	2	2	2
V_6	P_1	2	2	3	2	2
	P_2	2	2	2	2	2
	P_3	2	1	3	2	2

Scale	Description
1	Like very much
2	Like moderately
3	Neither like nor dislike
4	Dislike moderately
5	Dislike very much

General acceptability. The overall Dhal quality was measured on their general acceptability as shown in table 8b. Dhal chickpea Kabuli ICCV 92311 were rated 1 (like very much), and these was harvested at yellow pod stage; while Desi ICCV 93954 was rated 3 (neither like nor dislike) and these was harvested at yellow green pod stage.

Table 8b. Sensory evaluation (dhal)

TREATMENTS		COLOR	SMELL	TEXTURE	TASTE	ACCEPTABILITY
V1	P_1	3	2	3	3	2
	P_2	2	1	2	2	2
	P_3	3	2	3	2	2
V_2	P_1	4	2	2	4	3
	p_2	2	2	2	2	2
	P_3	2	2	2	2	2
V_3	P_1	3	2	2	4	2
	P_2	2	2	2	2	2
	P_3	2	2	2	2	2
V_4	P_1	2	2	2	2	2
	P_2	1	3	1	1	1
	P_3	2	2	2	2	2
V_5	P_1	2	4	3	2	2
	P_2	1	2	2	2	2
	P_3	2	3	2	1	2
V_6	P_1	2	5	4	2	2
	P_2	2	4	3	2	2
	P_3	2	4	4	2	2

Scale	Description
1	Like very much
2	Like moderately
3	Neither like nor dislike
4	Dislike moderately
5	Dislike very much

SUMMARY, CONCLUSION AND RECOMMENDATION

Summary

The study was conducted to determine the postharvest and processing qualities of chickpea harvested at different maturity indices and to identify the chickpea cultivar that has better postharvest and processing qualities when harvested at different maturity indices. The study was conducted at the Balili Experimental Station of the Benguet State University, La Trinidad Benguet from November 2009 to December 2010.

Results showed significant differences between the variety and maturity index. On the germination test through Petri dish method Desi type variety ICCV 06102 harvested at yellow pod stage obtained the highest germination percentage while Kabuli variety ICCV 07307 harvested at yellow green pod stage, had the lowest germination percentage. For the number of days from planting to harvesting Kabuli variety ICCV 95334 harvested at yellow green pod stage were the earliest to reach harvesting stage while Desi type variety ICCV 93952 had the longest duration to harvesting.

ICCV 07307 a Kabuli type variety harvested at yellow brown pod stage had the heaviest weight of 100 seeds; while ICCV 93954 harvested at yellow green pod stage had the lightest weight of 100 seeds.

With regards to the Dhal milling percentage, result revealed that Kabuli type variety ICCV 07307 harvested at yellow brown pod stage had the highest Dhal milling percentage. However on the cookability of the whole seeds and Dhal (split remove seed coat) Kabuli variety ICCV 95334 harvested at yellow green pod stage had the highest cookability of the dry seeds; while Desi variety ICCV 93954 had the highest cookability percentage of Dhal seeds.

As to the number of days from cooking to initial fungal development of the whole grain and the Dhal, both Kabuli type varieties ICCV 95334 and ICCV 92311 were the latest to initiate initial fungal development and these were harvested both at yellow brown pod stage, while ICCV 95334 were the earliest to initiate fungal development on the cooked Dhal.

On the evaluation of the whole grain and the Dhal, concerning the color, smell, texture, and the general acceptability, Kabuli type variety ICCV 92311and ICCV 95334 were judged as 'liked very much' in color, texture, and taste by the majority of the evaluators and had a General acceptability on the whole grain and Dhal; both were harvested at yellow pod stage. Desi type variety ICCV 93954 was judged as 'dislike moderately' by the evaluators and were harvested at yellow green pod stage.

Conclusion

Based on the results presented and discussed, Kabuli type variety ICCV 07307 had the heaviest 100 seeds weight and had the highest Dhal milling percentage harvested at yellow brown pod stage (from ICRISAT). ICCV 95334 had the highest cookability percentage of whole grain and were the latest to initiate initial fungal development when harvested at yellow green pod stage and yellow brown pod stage. On the sensory test Kabuli type variety ICCV 95334 and ICCV 92311 were rated like very much in terms of the color, texture, taste and general acceptability; while on the germination test done through Petri dish method Desi variety ICCV 06102 harvested at yellow pod stage had the highest germination percentage.

Recommendation

Based on the results and findings of this study, it is therefore recommended that, for postharvest and processing, chickpea should be harvested at yellow pod stage and yellow brown pod stage and to grow the Kabuli type variety ICCV 92311 and ICCV 95334 for these varieties had the best sensory evaluation and latest fungal development. ICCV 07307 harvested at yellow brown pod stage is also recommended for higher milling (Dhal) percentage.

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APPENDICES

Appendix Table 1. Germination test (%)

TREATMENT		REPLICATION			TOTAL	MEAN
		I	II	III		
V_1	P_1	94	86	94	274	91.3
	P_2	94	100	96	290	96.7
	P_3	98	94	94	286	95.3
V_2	P_1	84	94	94	272	90.7
	P_2	98	96	94	288	90.7
	P_3	96	90	94	280	93.3
V_3	P_1	98	90	90	278	92.7
	P_2	94	92	100	286	95.3
	P_3	94	94	100	288	96.0
V_4	P_1	92	92	86	270	90.0
	P_2	88	82	84	254	84.7
	P_3	86	84	80	250	83.3
V_5	P_1	48	60	36	144	48.0
	P_2	88	84	92	264	88.0
	P_3	74	82	68	224	74.7
V_6	P_1	36	54	70	162	54.0
	P_2	86	74	68	228	76.0
	P_3	58	80	44	182	60.7

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F	
					0.05	0.01
Block	2	1168.00	686.94	11.89		
Variety (A)	5	8253.10	1650.62	28.57*	<.00	
Planting Distance (B)	2	1203.10	601.56	10.41 ^{ns}	0.0003	
A X P	10	2221.78	222.17	3.85*	0.0013	
Error	34	2080.00	57.78			
TOTAL	53	13758.00				

* - Significant
^{ns} – Not significant

Coefficient of variation = 9.1%

Appendix Table 2. Days from planting to harvesting

TREATMENT		REPLICATION			TOTAL	MEAN
		I	II	III		
V_1	P_1	117	120	116	353	`117
	P_2	127	123	126	376	125.3
	P_3	138	134	138	399	133
V_2	P_1	116	123	117	356	118.7
	P_2	128	134	128	390	130
	P_3	134	138	138	410	136.7
V_3	P_1	117	116	122	355	118.3
	P_2	128	126	123	377	125.7
	P_3	138	134	136	408	136
V_4	P_1	121	117	116	354	118
	P_2	134	130	126	390	130
	P_3	134	134	128	396	132
V_5	P_1	119	116	117	352	117.3
	P_2	124	134	126	384	128
	P_3	130	134	134	398	132.7
V_6	P_1	116	123	117	356	118.7
	P_2	134	134	126	394	131.3
	P_3	134	134	138	406	135.3

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F	
					0.05	0.01
Block	2	2736.10	180.94	16.28		
Variety (A)	5	49.43	9.89	1.00 ^{ns}	<.00	
Planting Distance (B)	2	2576.26	1288.13	130.26*	0.4319	
A X P	10	110.41	11.04	1.12*	0.3770	
Error	34	356.00	9.89			
TOTAL	53	3092.10				

* - Significant
^{ns} – Not significant

Coefficient of variation = 2.47%

Appendix Table 3. Weight of 100 seeds

TREATMENT		REPLICATION			TOTAL	MEAN
		I	II	III		
V_1	P_1	29.2	22.7	25.7	77.6	25.9
	P_2	27.7	29.6	27.8	85.1	28.4
	P_3	29.3	29.2	25.9	84.4	28.1
V_2	P_1	26.3	25.7	25.9	77.9	26
	P_2	24.7	25.3	24.4	74.4	25
	P_3	27.8	24.6	26.5	78.9	26.3
V_3	P_1	24.8	25.6	28.1	78.5	26.23
	P_2	26.0	30.8	29.4	86.2	28.7
	P_3	29.3	26.7	27.9	83.9	28
V_4	P_1	31.5	32.2	32.4	96.1	32
	P_2	29.0	31.1	28.6	88.7	29.6
	P_3	34.3	27.2	36.2	97.7	32.6
V_5	P_1	35.1	36.1	34.4	105.6	35.2
	P_2	33.7	34.3	35.2	103.2	34.54
	P_3	30.1	33.1	32.5	95.7	31.9
V_6	P_1	36.0	34.4	35.0	105.4	35.1
	P_2	34.2	36.0	33.0	103.2	34.4
	P_3	33.4	35.0	34.4	102.8	34.3

ANALYSIS OF VARIATION

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F	
					0.05	0.01
Block	2	675.99	99.76	11.72		
Variety (A)	5	615.95	123.19	36.32 *	<.00	
Planting Distance (B)	2	0.25	0.12	0.03 ^{ns}	0.9674	
A X P	10	50.81	5.98	1.76 *	0.10	
Error	34	122.10	3.39			
TOTAL	53					

* - Significant
^{ns} - Not significant

Coefficient of variation = 6.12%

Appendix Table 4. Dhal milling percentage

TREATMENT		REPLICATION			TOTAL	MEAN
		I	II	III		
V_1	P_1	79.7	79.6	82.4	241.7	80.6
	P_2	82.9	80.9	83.3	247.1	82.4
	P_3	82.0	82.1	82.8	246.9	82.3
V_2	P_1	81.8	82.5	84.1	248.4	82.8
	P_2	80.5	80.1	81.4	242.0	80.7
	P_3	82.7	82.2	82.2	247.1	82.4
V_3	P_1	82.6	80.0	78.8	241.4	80.5
	P_2	83.5	82.7	83.9	250.1	83.4
	P_3	82.7	85.0	84.2	251.9	84.0
V_4	P_1	88.8	89.3	90.1	268.2	89.0
	P_2	89.6	89.0	88.1	266.7	88.9
	P_3	91.2	89.7	87.9	268.0	89.6
V_5	P_1	90.3	89.7	89.0	269.0	89.7
	P_2	90.3	91.1	89.5	270.9	90.3
	P_3	87.7	89.5	89.2	266.4	88.8
V_6	P_1	92.7	87.0	86.7	266.4	88.8
	P_2	91.0	90.3	90.7	272.0	90.7
	P_3	92.5	91.5	93.4	277.4	92.5

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR 0.05	TABULAR 0.01
Block	2	882.33	51.90	31.17		
Variety (A)	5	823.07	164.62	98.90 *	<.00	
Planting Distance (B)	2	15.36	7.67	4.61 *	0.0165	
A X P	10	43.89	4.39	2.64 *	0.0161	
Error	34	59.95	1.67			
TOTAL	53					

* - Significant

Coefficient of variation = 1.50%

Appendix Table 5. Cookability of dry seeds (whole grain)

TREATMENT		REPLICATION			TOTAL	MEAN
		I	II	III		
V_1	P_1	105	107	100	312	104
	P_2	105	110	109	124	108
	P_3	103	105	108	316	105.3
V_2	P_1	106	107	109	322	107.3
	P_2	107	108	109	324	108
	P_3	102	102	104	308	102.7
V_3	P_1	102	110	103	315	105
	P_2	101	102	100	303	101
	P_3	99	100	98	297	99
V_4	P_1	105	103	112	318	106
	P_2	106	104	100	310	103.3
	P_3	98	103	100	301	100.3
V_5	P_1	103	112	108	323	107.3
	P_2	115	105	102	322	107.7
	P_3	101	100	110	311	103.7
V_6	P_1	106	103	104	313	104.3
	P_2	105	106	104	315	105
	P_3	100	102	104	306	102

ANALYSIS OF VARIACE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F		TABULAR F 0.05	0.01
Block	2	384.81	22.64	2.10			
Variety (A)	5	148.59	29.72	2.75	*	<.00	
Planting Distance (B)	2	146.04	73.02	6.76	*	0.0032	
A X P	10	90.19	9.02	0.84	*	0.60	
Error	34	388.67	10.80				
TOTAL	53						

* - Significant Coefficient of variation = 3.14%

Appendix Table 6. Cookability of the Dhal seeds

TREATMENT		REPLICATION			TOTAL	MEAN
		I	II	III		
V_1	P_1	101	102	98	301	100.3
	P_2	100	98	100	298	99.3
	P_3	98	97	97	292	97.3
V_2	P_1	100	100	100	300	100
	P_2	99	102	99	300	100
	P_3	98	99	103	300	100
V_3	P_1	100	98	98	296	98.7
	P_2	100	99	97	296	98.7
	P_3	100	100	100	300	100
V_4	P_1	99	100	100	299	99.7
	P_2	97	100	99	294	98.0
	P_3	94	96	98	288	96.0
V_5	P_1	100	97	98	295	98.3
	P_2	102	100	100	302	100.7
	P_3	100	99	98	297	99.0
V_6	P_1	95	98	96	289	96.3
	P_2	96	90	96	282	94.0
	P_3	93	96	98	292	97.3

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F 0.05	0.01
Block	2	180.15	10.60	3.60		
Variety (A)	5	123.70	24.74	8.62 *	<.00	
Planting Distance (B)	2	7.26	4.92	1.26 ns	0.29	
A X P	10	49.19	3.63	1.71 *	0.12	
Error	34	103.33	4.92			
TOTAL	53					

* - Significant
ns - Not significant

Coefficient of variation = 1.72%

Appendix Table 7a. Days from cooking to initial fungal development (whole grain)

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
V_1 P_1	2	2	2	6	2
P_2	2	2	3	7	2.33
P_3	3	2	3	8	2.67
V_2 P_1	3	3	2	8	2.67
P_2	2	3	2	7	2.33
P_3	3	3	3	9	3
V_3 P_1	3	3	3	9	3
P_2	3	2	3	8	2.67
P_3	3	3	3	9	3
V_4 P_1	3	2	3	8	2.67
P_2	3	3	3	9	3
P_3	3	3	3	9	3
V_5 P_1	3	3	3	9	3
P_2	3	3	3	9	3
P_3	3	3	3	9	3
V_6 P_1	2	2	3	7	2.3
P_2	2	2	2	6	2
P_3	3	3	3	9	3

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F 0.05	TABULAR F 0.01
Block	2	0.26	1.30			
Variety (A)	5	3.529	0.652	5.03**	2.49	3.61
Planting Distance (B)	2	1.593	o.796	6.14**	2.88	4.42
A X B	10	1.741	0.174	1.34 ^{ns}	2.12	2.89
Error	34	4.407	0.130			
TOTAL	53	11.259				

** - Highly siginificant

Coefficient of variation = 13.32%

^{ns} - Not significant

Appendix Table 7b. Days from cooking to initial fungal development (Dhal seeds)

TREATMENT		REPLICATION			TOTAL	MEAN
		I	II	III		
V_1	P_1	3	3	3	9	3
	P_2	3	3	3	9	3
	P_3	3	2	3	8	2.67
V_2	P_1	3	3	3	9	3
	P_2	3	2	3	8	2.67
	P_3	3	3	3	9	3
V_3	P_1	3	2	2	6	2
	P_2	3	2	3	8	2.67
	P_3	3	3	3	9	3
V_4	P_1	3	3	3	9	3
	P_2	3	3	3	9	3
	P_3	3	3	3	9	3
V_5	P_1	2	2	2	6	2
	P_2	3	2	2	6	2
	P_3	3	2	2	8	2.67
V_6	P_1	2	2	2	6	2
	P_2	3	2	3	8	2.67
	P_3	2	2	2	6	2

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULAR F	
					0.05	0.01
Block	2	1.037	0.519			
Variety (A)	5	6.370	1.274	14.62**	2.49	3.61
Planting Distance (B)	2	0.148	0.074	0.85 ^{ns}	2.88	4.42
A X P	10	2.074	0.207	2.38*	2.12	2.89
Error	34	2.963	0.087			
TOTAL	53	12.593				

* - Significant
^{ns} - Not significant

Coefficient of variation = 11.23%

Appendix Table 8a. Sensory evaluation (whole grain)

		COLOR	SMELL	TEXTURE	TASTE	ACCEPTABILITY
V_1	P_1	2	3	2	2	2
	P_2	2	3	2	2	2
	P_3	2	3	2	2	2
V_2	P_1	2	4	2	4	4
	p_2	2	3	2	2	2
	P_3	2	3	2	2	2
V_3	P_1	3	3	2	3	4
	P_2	2	2	2	2	2
	P_3	2	2	2	2	2
V_4	P_1	2	2	2	2	2
	P_2	1	2	2	2	1
	P_3	2	2	2	2	2
V_5	P_1	2	2	2	2	2
	P_2	1	1	1	1	1
	P_3	2	2	2	2	2
V_6	P_1	2	2	3	2	2
	P_2	2	2	2	2	2
	P_3	2	1	3	2	2

Appendix Table 8a. Sensory evaluation (whole grain)

		COLOR	SMELL	TEXTURE	TASTE	ACCEPTABILITY
V1	P_1	2	3	2	2	2
	P_2	2	3	2	2	2
	P_3	2	3	2	2	2
V_2	P_1	2	4	2	4	4
	p_2	2	3	2	2	2
	P_3	2	3	2	2	2
V_3	P_1	3	3	2	3	4
	P_2	2	2	2	2	2
	P_3	2	2	2	2	2
V_4	P_1	2	2	2	2	2
	P_2	1	2	2	2	1
	P_3	2	2	2	2	2
V_5	P_1	2	2	2	2	2
	P_2	1	1	1	1	1
	P_3	2	2	2	2	2
V_6	P_1	2	2	3	2	2
	P_2	2	2	2	2	2
	P_3	2	1	3	2	2