4

RESULTS AND DISCUSSION

Save grain save life

A grain saved is a grain produced

The findings of the study on **"Effect of Different Botanicals on the Keeping Quality of Selected Pulses"** are discussed and presented under the following headings:

A. Results of the survey conducted
   1. Household Survey
   2. Market Survey

B. Assessing the keeping quality of selected stored pulses using different botanicals

C. Impact of the training programme on the use of botanicals during storage of pulses among the selected Homemakers and Shop keepers

A. Results of the survey conducted

1. Household Survey

The findings of the household survey are discussed under the following aspects,

a. Socio - economic profile of the selected households.
b. Purchase pattern and storage practices of pulses among the selected households.

a. Socio - Economic Profile of the Selected Households

The socio-economic profile reveals the information regarding the age, educational, occupational and marital status of the homemakers and the type of family, family size, stages in the family life cycle and monthly income of the selected households.

The data thus collected is presented in Table III.

TABLE – III

SOCIO-ECONOMIC PROFILE OF THE SELECTED HOUSEHOLDS

N=600

S.No	Particulars	Details	Percentage of households (%)										
			Anamalai Block					Pollachi Block					Total (%)
			V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	
1.	Age (in years)	Below 30	25	15	12	8	23	28	18	13	22	10	18
		30 – 40	33	27	43	44	27	27	38	24	30	25	32
		40 – 50	27	40	32	28	32	33	27	33	40	43	33
		50 and above	15	18	13	20	18	12	17	30	8	22	17
2.	Educational status (Homemakers)	Illiterate	12	19	27	17	10	23	10	8	10	20	15
		Primary	27	13	30	28	32	10	28	30	27	31	26
		Secondary	15	20	15	31	40	25	30	33	33	25	27
		Higher Secondary	33	33	23	20	15	37	25	20	25	17	25
		Graduate	10	9	5	2	0	3	5	7	3	7	5
		Post graduate	3	3	0	0	0	2	0	0	2	0	1
		Diploma	0	3	0	2	3	0	2	2	0	0	1
3.	Occupational status	Agriculture	95	94	90	88	94	86	92	85	94	89	78
		Business	3	2	3	4	5	12	5	9	2	7	12
		Private employee	2	3	2	5	1	2	2	4	3	3	5
		Government employee	0	1	3	2	0	0	1	1	1	0	3
		Entrepreneur	0	0	2	1	0	0	0	1	0	1	2
4.	Family type	Joint family	43	52	38	33	37	32	53	42	45	43	42
		Nuclear	57	48	62	67	63	68	47	58	55	57	58
5.	Family size	Small (up to 4 members)	31	25	33	17	30	28	15	22	23	25	25
		Medium (4-6 members)	47	55	52	60	50	48	63	68	60	58	56
		Large (more than 6 members	22	20	15	23	20	24	22	10	17	17	19
6.	Stages in the family life cycle	Beginning	27	22	28	32	25	28	10	33	32	25	26
		Expanding	53	50	47	40	57	54	57	55	40	45	50
		Contracting	20	28	25	28	18	18	33	12	28	30	24
7	Monthly family Income in (`.) (HUDCO)	Low (` 2500-4500)	25	20	15	30	20	15	17	20	23	27	21
		Middle (`. 4501-7500)	55	65	68	50	62	60	73	65	58	61	62
		High (Above `. 7501)	20	15	17	20	18	25	10	15	19	12	17

V1 - Anamalai, V2 - Angalakurichi, V3 - Kaliapuram, V4 - Periapodu, V5 - Thenchittur, V6 - Kolarpatti, V7 - Koolanaickenpati, V8 - Makkinampatti, V9 - Samathur, V10 - Sinjuvadi.

Age was found to be a factor influencing the extent of involvement in various decision making process. From the above table, it is clear that, out of the 600 homemakers, 33 per cent belonged to the age group of 40-50 years, followed by 32 per cent belonged to the age group of 30 - 40 years. Eighteen per cent were below 30 years while 17 per cent were aged above 50 years.

With regard to the marital status, ninety per cent of them were married. Regarding educational status, twenty seven, 26 and 25 per cent of them had different levels of school education namely secondary level, primary level and higher secondary level respectively. Only a meager per cent (7%) of them had college education and 15 per cent of the surveyed homemakers were illiterates.

Occupation is to be treated as the most important key factor to determine the source of income. It reflects the outcome of educational attainment, provides information about the skills and credentials required to obtain a job and the associated monetary and other rewards. The occupation also determines the standard of living of the households. Agriculture was the main occupation for majority (78 per cent) of the households and they were also involved in its allied activities. Twelve per cent of households were doing own business like garment unit, transport and real estate. Five per cent were private employees while three per cent were government employees and about two per cent were entrepreneurs who were involved in small scale business like pickle making and coir making.

The above table also reveals that 58 per cent of the households belonged to nuclear family while 42 per cent belonged to joint family. This is due to rapid urbanization which leads to migration of families and the ultimate shrinking of the family size.

With regard to the family size, 56 per cent of the households belonged to medium sized family (4-6 members) while 25 per cent of the households belonged to small family (upto 4 members) followed by 19 per cent of the households in the large sized family (above 6 members). It is worth to state that family size is critically associated with homemakers' participation of in different activities.

Regarding the stages of family life cycle, 50 per cent of them belonged to expanding stage of family life cycle while 26 per cent of them belonged to beginning stage and the remaining 24 per cent were in the contracting stage.

According to Housing and Urban Development Corporation (HUDCO), 2006, the total family income per month for low income groups range from Rs 2500 to 4500, for middle income Rs. 4501 to 7500 and for high income Rs. 7501 and above. Based on the above classification, 62 per cent of the selected families belonged to middle income group while 21 per cent were grouped under low income group followed by 17 per cent being high in income group.

b. Purchase and storage practices of pulses among the selected households

This part of the study presents information regarding the frequency of purchasing pulses, quantum purchased, duration of storing different pulses, storage devices/containers used for storage, problems identified during storage, degree of susceptibility of pulses to spoilage and damage by insects and pests, percentage of loss, methods adopted to overcome problems and mode of discarding the infected pulses are presented blow

i. Frequency of purchasing pulses

The data regarding frequency of purchasing pulses by the selected homemakers were collected and is presented in Table IV.

TABLE IV

FREQUENCY OF PURCHASING PULSES

N=600

S.No	Frequency of purchase	Number (N)	Percentage (%)
1	Weekly	18	3
2	Monthly	180	30
3	Once in 3 months	294	49
4	Once in 6 months	108	18

The above table indicated that 49 per cent of the households purchased pulses once in three months while 30 per cent purchased once in a month. Pulses were also purchased once in 6 months by 18 per cent of the households. The result

thus obtained clearly reveals that pulses are stored for a considerable period by majority of the households for future use as seed purpose and household consumption.

ii. Quantum of pulses stored

Information on average quantum of pulses stored for six months by the selected households is presented in Table V.

TABLE V

AVERAGE QUANTUM OF PULSES STORED FOR SIX MONTHS BY THE SELECTED HOUSEHOLDS

N = 600

S.No	Pulses	Average quantity purchased per month (kg)
1	Black gram	25
2	Green gram	20
3	Cowpea	8
4	Horse gram	5
5	Black channa	5
6	Peas	5

Table V clearly indicated that on an average, around 68 kgs of different varieties of pulses were stored by the selected homemakers for a period of six months. On an average 25 kgs of black gram, 20 kgs of green gram and 8 kgs of cowpea were stored for six months. Majority of the households being in medium size family (4-6 members) and also in the expanding stage of life cycle, they consumed more pulses in the form of different preparations. From the survey, it is understood that on an average the individual consumption of pulses per day is 40 - 58g. The average daily intake of pulses recommended by FAO is 40g/cu/day (FAO Document Repository, 2012). In the adopted villages, since pulses production and its availability were more, the consumption level of pulses is on par with the recommended level.

iii. Duration of storing different pulses

The details on duration of storing different pulses were collected to substantiate the need for training the homemakers. The data thus collected is presented in Table VI.

TABLE VI

DURATION OF STORING DIFFERENT PULSES

N =600

S.No	Types of pulses	Duration of storage							
		1 month		2 months		3 months		6 months	
		No	%	No	%	No	%	No	%
1.	Green gram	12	2	48	8	72	12	468	78
2.	Black gram	24	4	30	5	108	18	438	73
3.	Cowpea	30	5	72	12	108	18	390	65
4.	Peas	150	25	282	47	96	16	72	12
5.	Black Channa	240	40	168	28	120	20	72	12
6.	Horse gram	96	16	330	55	132	22	42	7

The above table revealed that, out of the six pulses, black gram, green gram and cowpea were being stored for 6 months as practiced by more than 50 per cent of households. The reason might be attributed to the fact that these pulses are mostly cultivated in the villages and are also available at reasonable cost during its harvest season. This may also be a reason for storing large quantities of pulses for a longer period.

iv. Storage devices / containers used for storage of pulses

Information regarding the storage devices / containers used to store pulses was collected to know about pulses storage practices adopted by the households. The data thus collected is presented in Table VII and Figure 4.

TABLE VII

STORAGE DEVICES / CONTAINERS USED

N =600

S.No	Storage Devices/ Containers used	Number (N)	Percentage (%)
1.	Air tight stainless steel	450	75
2.	Glass bottles	84	14
3.	Plastic container	42	7
4.	Gunny bags	12	2
5.	Polythene bags	6	1
6.	Plastic covers	6	1

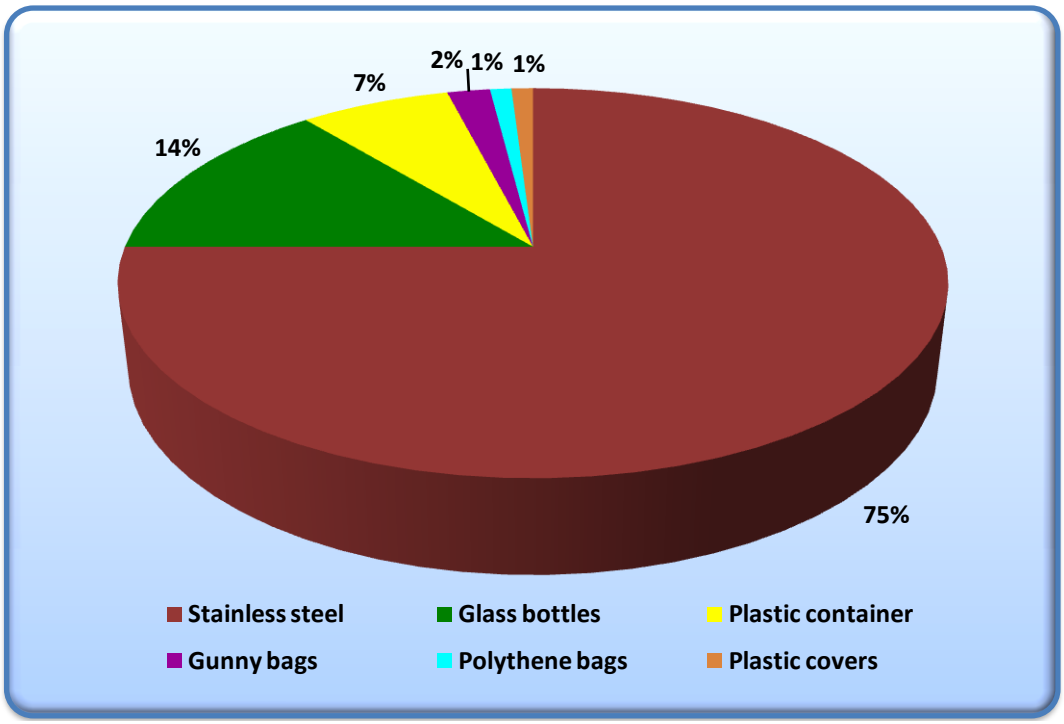


Figure 4

Storage devices used by the selected households

Table VII showed that 75 per cent of the homemakers stored pulses in air tight stainless steel containers. It was preferred mostly by the homemakers due to its easy and safe handling. Moreover airtight containers have the added advantage that with time oxygen levels decrease and carbon dioxide levels rise as a result the insect population may die during storage. Glass bottles and plastic containers were also used by 14 and seven per cent of the homemakers respectively. Gunny bags, polythene bags and plastic covers were the other storage devices used by very few homemakers.

v. Problems identified during storage of pulses

Identifying the problems during storage of pulses is equally important in minimizing its losses during storage. The data thus collected from homemakers is presented in Table VIII and Figure 5.

TABLE VIII

PROBLEMS IDENTIFIED DURING STORAGE OF PULSES

N =600

S.No	Problems identified*	Number (N)	Percentage (%)
1.	Presence of holes/white spot	516	86
2.	Insect and pest infestation	462	77
3.	Presence of powdery substances	384	64
4.	Fungal and mold attack	258	43
5.	Increased moisture content	150	25
6.	Clustering of pulses	144	24
7.	Presence of worms	132	22
8.	Discolouration	48	8
9.	Decay	30	5
10.	Bad odour	24	4

* Multiple Responses

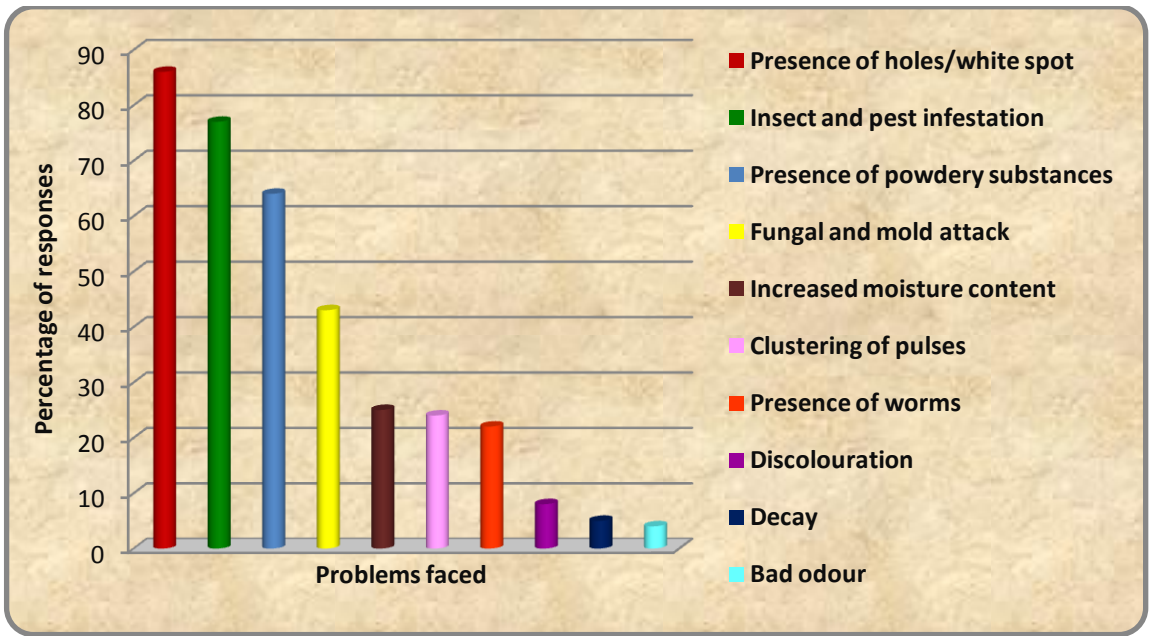


Figure 5

Problems identified during storage of pulses as expressed by the homemakers

From the above table, it could be revealed that majority of 86, 77 and 64 per cent of the surveyed homemakers' responded that presence of holes / white spots, insect and pest infestation and presence of powdery substances respectively as the major problems identified during storage of pulses. The other responses by the homemakers were fungal and mold attack, increasing moisture content, clustering of pulses presence of worms, discolouration, decay and bad odour. An understating about the simple techniques in solving the problem might lend a hand to the homemakers that would result in ultimate reduction in storage loss.

vi. Percentage loss of pulses during storage

Table IX presents the data regarding the pulses losses experienced by the selected homemakers during six months storage period.

TABLE IX

PERCENTAGE LOSS OF PULSES DURING STORAGE

N=600

S.No	Name of the Pulses	Percentage loss				
		6-8%	8-10 %	10-12%	12-14%	14-16%
1.	Black gram	5	7	28	40	20
2.	Black channa	7	40	45	8	-
3.	Cowpea	-	8	48	20	24
4.	Green gram	3	7	15	20	55
5.	Peas	34	18	42	6	-

The above table revealed that maximum 12-14 per cent of black gram gets damaged during six months storage period due to insect, pest and fungal attack as expressed by 40 per cent of homemakers. Forty five and 40 percent homemakers responded 10-12 per cent and 8-10 per cent of pulse loss respectively with regard to black channa during 6 months of storage period. Forty eight per cent of homemakers stated that 10-12 per cent of pulse damage was identified in cowpea. Fifty five percent of homemakers reported 14 -16 per cent, of loss in green gram. Forty two

percent of homemakers experienced 10-12 per cent of loss in peas. Similar study was done by Sinha and Sinha (1990). They concluded from their research that most of the insect species have remarkably high rates of multiplication and they destroy 10-15 per cent of the grain and contaminated the rest with undesirable odors and flavors. White (2001) also revealed in his study that pulses on storage are prone to insects and pest attack and thereby its damage was more during storage that affects both quality and quantity. This result clearly reveals the felt need of training the homemakers on proper storage practices.

vii. Degree of susceptibility of pulses to spoilage and damage by insects and pests

The data regarding the degree of susceptibility of pulses to spoilage and damage by insects and pests is presented Table X and Plate 15.

TABLE X

DEGREE OF SUSCEPTIBILITY OF PULSES TO SPOILAGE AND DAMAGE BY INSECTS AND PESTS

N= 600

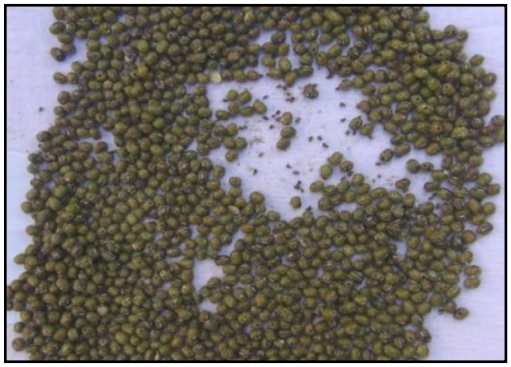
S.No	Pulses*	Number (N)	Percentage (%)
1	Green gram	450	75
2	Black gram	408	70
3	Cowpea	390	68
4	Horse gram	420	65
5	Black Channa	372	58
6	Peas	330	55

* Multiple Responses

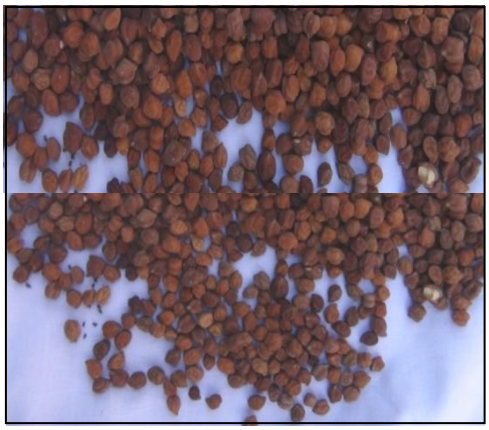
From the above table, it could be understood that green gram (75 per cent), black gram (70 per cent), cowpea (68 per cent), horse gram (65 per cent), black channa (58 per cent) and peas (55 per cent) were more prone to rapid spoilage and damage by insects and pests as expressed by the surveyed homemakers. These responses are in tune with the study done by Rani and Mohan (2007). They estimated the storage loss at household level and concluded a highest loss among black gram followed by green gram and cowpea.

Cowpea

White Channa



Green Gram



Black Channa

Horse Gram

Plate 15

Insect Infected Pulses during Storage

fviii. Methods adopted to overcome problems faced during storage of pulses

The methods adopted to overcome the problems during storage of pulses are presented in Table XI.

TABLE XI

METHODS ADOPTED TO OVERCOME PROBLEM FACED DURING STORAGE OF PULSES

N=600

S.No	Methods Adopted	No	per cent
1	Chemical Methods	6	1
2	Organic Methods	18	3
3	Physical Methods	72	12
4	None	504	84

It is evident from the above table that a majority (84 per cent) of the homemakers did not take any measures to overcome problems faced during storage of pulses. Though awareness on the use of botanicals during storage of pulses to prevent insect and pest damage was very little, they did not practice it in their day to day life. Physical methods like cleaning, sun drying and winnowing were adopted by 12 per cent of homemakers. It is disappointing to note that only 3 per cent of the homemakers adopt the cost effective organic methods like storing pulses with neem leaf, tulsi, and red soil to overcome the storage problems. It was also noted that one per cent of them used chemical methods to protect pulses from storage problems.

ix. Mode of discarding the infected pulses

The data regarding the mode of discarding the spoiled pulses is furnished in Table XII.

TABLE XII

DISPOSAL OF INFECTED PULSES

N=600

S.No	Particulars	Number (N)	Percentage (%)
1	Discarded as waste	366	61
2	Cattle /animal feed	162	27
3	Removal of pest and used for cooking	48	8
4	Made into flour	24	4

A majority of about 61 per cent of homemakers discarded the infested pulses as waste while 27 per cent used infested pulses as cattle/animal feed. Twelve per cent of the homemakers used the infested pulses after removal of pest in the form of whole grain (8 per cent) or in the form of flour (4 per cent).

2. Market Survey

A market survey was conducted among 16 provision shops from the selected 10 villages of Anamalai and Pollachi block. The aspects discussed under this are frequency of procuring pulses, quantum of pulses procured and sold per month, purchasing and consumption pattern of pulses by the consumers, problems faced in storing pulses, method of handling spoiled and infested pulses and opinion regarding improved storage practices of pulses.

a. Frequency of procuring pulses

The data on frequency of procuring pulses by the shop keepers in the selected provision shops is a key point in identifying the overall pulses consumption of the households. The data thus collected is presented in Table XIII.

TABLE XIII

FREQUENCY OF PROCURING PULSES

N=16

S.No	Frequency of procurement	Number (N)	Percentage (%)
1	Fortnightly	3	19
2	Monthly	8	50
3	Bimonthly	5	31

The above table revealed that 50 per cent of the shop keepers procured pulses on monthly basis while 31 per cent procured once in two months followed by 19 per cent who procured once in 15 days. Although pulses are purchased on a cyclic basis, the shop keepers procured pulses depending on the stock position and unforeseen bulk demand by the consumers as the case may be.

It was also noted that there are chances of insect, pest, fungal and mould attack in stored pulses in the provision stores which might be attributed to the facts like unhygienic practices, lack of proper infrastructure facilities for storage, probable biological attack from the immediate environment as observed by the investigator.

b. Quantum of pulses procured and sold per month

The details of quantum of pulses procured and sold per month by the shop keepers were collected and is presented in Table XIV.

TABLE XIV

QUANTUM OF PULSES PROCURED AND SOLD PER MONTH

N=16

S.No	Name of the pulses	Quantity Purchased (in Kgs)	Quantity Sold (in Kgs)
1	Black gram	100	82
2	Red gram dhal	100	80
3	Green gram	80	75
4	Green gram dhal	80	60
5	Black gram dhal	80	50
6	Cowpea	75	50
7	Black channa	25	20
8	Peas	25	10
9	Horse gram	25	10
10	White channa	25	5
11	Rajma	10	5
12	Soya bean	10	5

The above Table indicated that among the pulses, black gram, red gram dhal and green gram were sold at an average quantum of 82, 80 and 75 kgs per month respectively. Green gram dhal, black gram dhal and cowpea were sold moderately which were quantified to 60, 50 and 50 kgs per month respectively. The other pulses namely black channa, peas, horse gram, bengal gram whole (black and white), rajma and soya bean were sold only in limited quantities. This difference in quantum of pulses sold is mainly due to pulses consumption pattern. According to the selling pattern of pulses, the shop keepers purchased and maintained a buffer stock at least a minimum of 5 kgs.

c. Selling pattern of pulses as expressed by the shop keepers

The shop keepers expressed that pulses like black gram, red gram dhal, green gram, green gram dhal, black gram dhal and cowpea were the pulses consumed frequently on a regular basis and so these pulses were sold more frequently. Hence they were purchased in bulk quantities by the shop keepers since these pulses find prominent place in the South Indian recipes. Cowpea, horse gram, peas and bengal gram (white and black varieties) were purchased by the consumers moderately followed by rajma, soya bean.

d. Problems faced in storing pulses

The main problems expressed by the shop keepers were insect and pest attack, rodent and cockroach attack, fungal attack, weight loss and quality deterioration during storage of pulses. Shop keepers felt inadequate storage space as major contributing factor for experiencing these problems.

e. Percentage losses of pulses during storage in the selected shops

The data on the per cent losses of pulses identified during storage as expressed by the shop keepers during two months storage period is furnished in Table XV.

TABLE XV

PERCENTAGE LOSSES OF PULSES DURING TWO MONTHS STORAGE IN THE SELECTED SHOPS

N=16

S.No	Name of the Pulses	Percentage of loss				
		6-8%	8-10 %	10-12%	12-14%	14-16%
1.	Black gram	4	8	42	30	16
2.	Black channa	7	30	23	22	18
3.	Cowpea	8	15	32	25	20
4.	Green gram	0	7	58	23	12
5.	Peas	23	19	24	18	16

The above table revealed that about 10-12 per cent of black gram gets damaged during storage due to insect, pest, rat and fungal attack as expressed by maximum 42 per cent of shop keepers. Thirty and 23 per cent of the shop keepers experienced 8-10 per cent and 10-12 per cent of loss of black channa respectively. Thirty two and 25 percent shop keepers expressed 10-12 per cent and 12-14 per cent loss in cowpea during storage. Fifty eight, 23 and 12 percent of shopkeepers experienced 10-12 per cent, 12-14 per cent and 14-16 per cent of loss in green gram. Twenty four per cent of the shop keepers experienced 10-12 per cent loss of pulse in peas. It is worthy to note from the survey that the percentage of loss is more in shops when compared to households. It might be due to various reasons like unhygienic condition of storage room, improper handling of pulses, cleanliness, existing climatic and environmental condition.

f. Method of Handling spoiled and infested pulses

Majority (60 per cent) of the shop keepers responded that pulses spoilage and damage were minimized by purchasing pulses based on the demand basis. Forty per cent of the shop keepers took measures like discarding the infested pulses, selling at low cost and distributing to farmers for animal feed. Generally, the shop keepers convert the infested pulses into flour. This fact was not expressed by the shop

keepers of the present study as they thought it might affect the good will of their shop. However this information was revealed by their neighbours.

g. Other opinion on storage of pulses

The shop keepers opined that pulses are purchased by all income groups. The results of the market survey revealed that since pulses production is seasonal, both consumers and shop keepers procured them in bulk quantities during seasons and stored them for its consumption during offseason. They also expressed that since pulses are prone to insect, pest and other biological attack, some simple and feasible natural techniques to control them might be helpful.

B. Assessing the keeping quality of selected stored pulses using different botanicals

Keeping quality of pulses is the stability of pulses when kept for long period of time under specified storage condition. To conserve the quality of products over long-term storage, degradation processes must be slowed down or even stopped. Degradation of pulses during storage depends principally on a combination of four factors viz. time, temperature, humidity and moisture.

Most important factors of pulses deterioration are the interaction of temperature, humidity and moisture, which are the determining factors in accelerating or delaying the complex phenomena of the biochemical transformation (especially the “breathing” of the pulses) that are the basic origin of pulses degradation. Furthermore, these have a direct influence on the speed of development of insects and microorganism (moulds, yeast and bacteria), and on the premature and germination of pulses without seasons. In general, the higher these factors are, the more rapidly the pulses deteriorate (Lal and Verma, 2007).

In this study, the keeping quality of pulses stored with different botanicals in three variations in the form of three different storage devices are assessed in terms of moisture content of pulses, weevilization percentage, germination percentage, organoleptic qualities of the dishes prepared using pulses at the end of 0020 six months storage period and temperature and relative humidity during the study period.

The findings are discussed under following headings

1. Effect of botanicals on moisture content of selected pulses at the end of sixth month
2. Effect of botanicals on average moisture content of selected pulses
3. Effect of botanicals on weevilization percentage of selected pulses
4. Effect of botanicals on average weevilization percentage of selected pulses
5. Effect of botanicals on germination percentage of selected pulses
6. Effect of botanicals on average germination percentage of selected pulses.
7. Average organoleptic quality of the prepared dishes stored with botanicals
8. Ambient Room Temperature during the study period.
9. Relative Humidity during the study period.

1. Effect of botanicals on the moisture content of selected pulses at the end of sixth month

Moisture is the key to the safe storage of pulses. The amount of moisture in the pulses is the most important factor influencing pulses viability during storage. Generally if moisture content of the pulses increases, storage life decreases. If pulses are kept at high moisture content then loss could be very rapid due to mould growth. Very low moisture content below 4 per cent may also damage seeds due to extreme desiccation. Since the keeping quality of pulses largely revolves around its moisture content, it is necessary to dry pulses to safe moisture contents. The safe moisture content however depends upon length of storage period, type of storage device, kind / variety of pulses stored (http://www.fao.org/docrep/x5738e/x5738e0e.htm").

Details on moisture content percentage of the selected stored pulses in the initial period and at the 6^{th} month of storage period are presented in Table XVI and Figure 6a. Results observed from all the three storage devices (stainless steel container, polythene bag and gunny bag) was also given for comparison.

TABLE XVI

EFFECT OF BOTANICALS ON THE MOISTURE CONTENT OF SELECTED PULSES AT THE END OF SIXTH MONTH

Pulses		Initial	Experimental Group												Control Group
			Azadirachta indica (Neem)				*Vitex nigundo* (Nochi)				*Pongamia pinnata* (Pongamiya)				
			Botanical Variations												
			10g	15g	20g	25g	10g	15g	20g	25g	10g	15g	20g	25g	
Black Gram	SS	12.6	14.2	14.0	13.9	13.9	14.5	14.2	14.1	14.1	14.6	14.5	14.3	14.3	16.5
	PB	12.6	14.2	14.1	13.9	13.9	14.6	14.3	14.3	14.3	14.7	14.6	14.4	14.4	16.7
	GB	12.6	14.2	14.2	13.9	13.9	14.5	14.3	14.3	14.4	14.7	14.6	14.5	14.5	16.8
Black Channa	SS	11.0	12.7	12.6	12.4	12.4	13.0	12.9	12.6	12.6	13.2	13.0	12.7	12.7	13.5
	PB	11.0	12.6	12.5	12.5	12.4	13.0	12.9	12.7	12.7	13.1	13.1	12.8	12.8	13.7
	GB	11.0	12.8	12.7	12.7	12.6	13.0	12.9	12.8	12.8	13.1	13.0	12.9	12.9	14.2
Cowpea	SS	13.8	16.1	16.0	15.7	15.7	15.9	15.7	15.5	15.5	16.2	16.1	15.9	15.8	16.9
	PB	13.8	16.2	16.0	15.8	15.8	15.9	15.7	15.6	15.6	16.3	16.2	15.9	15.9	17.2
	GB	13.8	16.2	16.0	15.9	15.9	15.9	15.8	15.7	15.7	16.3	16.2	16.0	16.0	17.4
Green Gram	SS	11.2	13.6	13.5	13.3	13.3	13.9	13.8	13.5	13.5	14.1	14.0	13.6	13.6	14.5
	PB	11.2	13.6	13.5	13.3	13.3	14.0	13.8	13.6	13.5	14.1	14.0	13.6	13.6	14.8
	GB	11.2	13.6	13.5	13.4	13.4	14.0	13.8	13.6	13.6	14.1	13.9	13.7	13.6	14.8
Peas	SS	13.6	15.7	15.6	15.3	15.3	15.5	15.3	15.1	15.1	15.8	15.7	15.4	15.4	16.5
	PB	13.6	15.4	15.3	15.2	15.2	15.3	15.2	15.1	15.1	15.5	15.4	15.3	15.3	16.8
	GB	13.6	15.7	15.6	15.4	15.3	15.5	15.4	15.2	15.2	15.8	15.7	15.5	15.5	16.8

SS – Stainless steel container PB – Polythene bag GB – Gunny bag

On the basis of the trial experiment, among the four variations - 10, 15, 20, 25 g/kg of *Azadirachta indica* (neem), *Vitex nigundo* (nochi) and *Pongamia pinnata* (pongamiya) leaf powders, 20 and 25 g/kg of these botanical leaf powders proved to be more or less similar in terms of their efficiency to maintain moisture level.

The data from the above table on the analysis of moisture content revealed that 25g/kg of *Azadirachta indica* (neem) leaf powder had high moisture control in black gram, green gram and black channa compared to other botanicals. With regard to cowpea and peas, *Vitex nigundo* (nochi) leaf powder in proportion of 25g/kg showed effective control of moisture.

The safe level of moisture content for pulses recommended by FCI was 1 2-15 percent. Black gram, black channa and green gram maintained safe moisture level upto 6 months in all the selected botanicals with all the variations. With regards to pea and cowpea, the moisture level was safe upto three months stored with different botanicals.

It was also noted that the initial moisture content of 12.6 in black gram increased to 16.5 in the control group, i.e. an 4 per cent increase in moisture was noticed while the same increased to 13.9, 14.1 and 14.3 per cent in black gram stored with neem, nochi and pongamiya respectively i.e. about 1 per cent (1.43%) increase in the pulses stored in air tight stainless steel container was noticed. The risk of weevilization generally increases with increase in moisture content, thus was also evident from the experiment on weevilization and hence the botanicals proved to be efficient in controlling occurrence and damage caused by insects and pests.

It was observed from the experiment that, among all the pulses of control group, the increase in moisture content was approximately 1 per cent every month and hence there are chances for 2 fold reduction in keeping quality every month according to the proven rule (Hayma, 2003). The same trend was observed in gunny and polythene bag. The detailed moisture content for every month is given in Appendix VIII. The experiment on moisture content revealed that botanicals could play a significant role in minimizing storage losses due to insect and pest attack. It is scientifically proven that for every decrease of 1% moisture content the life of the

pulses doubles as applicable to pulses and seeds with moisture content between of 5-14% (http://agritech.tnau.ac.in).

2. Effect of botanicals on average moisture content of selected stored pulses

The average moisture content of pulses stored in three different storage devices at the sixth month of storage period was presented in Table XVII.

TABLE XVII

AVERAGE MOISTURE CONTENT OF SELECTED STORED PULSES

Botanicals	Average Moisture Content (%)				
	Black Gram	Black Channa	Cowpea	Green Gram	Peas
$Neem_{10}$	14.2	12.7	16.2	13.6	15.6
$Neem_{15}$	14.1	12.6	16.0	13.5	15.5
$Neem_{20}$	13.9	12.5	15.8	13.3	15.3
$Neem_{25}$	13.9	12.5	15.8	13.3	15.3
$Nochi_{10}$	14.5	13.0	15.9	14.0	15.4
$Nochi_{15}$	14.3	12.9	15.7	13.8	15.3
$Nochi_{20}$	14.2	12.7	15.6	13.6	15.2
$Nochi_{25}$	14.3	12.7	15.5	13.5	15.1
$Pongamiya_{10}$	14.7	13.1	16.3	14.1	15.7
$Pongamiya_{15}$	14.6	13.0	16.2	14.0	15.6
$Pongamiya_{20}$	14.4	12.8	15.9	13.6	15.4
$Pongamiya_{25}$	14.4	12.8	15.9	13.6	15.4
Control	16.7	13.8	17.2	14.7	16.7
SE_D	0.07	0.10	0.081	0.04	0.07
CD(5%)	0.14	0.22	0.16	0.10	0.21
CD(1%)	0.20**	0.30**	0.22**	0.14**	0.29**

SE_D – Standard error of the difference

CD – Critical difference

It could be observed that the effect of different botanicals namely *Azadirachta indica* (Neem), *Vitex nigundo* (Nochi) and *Pongamia Pinnata* (Pongamia) with different variations such as 10g, 15g, 25g and 25g were highly significant in all the

above selected pulses in terms of maintaining the safe moisture level over the control group. The statistical analysis ANOVA results are presented in Appendix IX. The table reveals the fact that the moisture content was higher in control group when compared to pulses stored with botanicals in all the five selected pulses.

In black gram, the effect of the neem i.e. 20g and 25g variations were highly significant over other botanical variations and control group in maintaining the safe moisture level during storage period. The average moisture content of pulses stored with 20 and 25 g neem powder were 13.9 per cent and in control group, it was 16.7 per cent. It was also observed that the difference in reduction of average moisture content of pulses stored with 20 and 25g neem powder was 2.8 per cent over the control group. The same trend was observed in black channa and green gram as well.

In cowpea and peas, the effect of the nochi in 25g variations was highly significant over other botanical variations and control group in terms of maintaining safe moisture level during storage period. The average moisture content due to nochi at 25 g variations were 15.5 and 15.1 per cent respectively while in control group, it was noticed to be 17.2 and 16.7 per cent. It was also observed that the difference in reduction of average moisture content of pulses stored with nochi at 25gm variation was 1.6 per cent in cowpea and peas over the control group.

It was inferred from the results that pulses stored with botanicals maintained low moisture level when compared to control group and thereby increasing its shelf life. Zia-Ur-Rehman (2006) also expressed that the stored pulses maintained at a sufficiently low moisture level can be stored for many years without any significant loss in quality.

3. Effect of botanicals on the weevilization percentage of selected pulses at the end of sixth month

Details on weevilization percentage of the selected stored pulses in the initial period and at the end of sixth month of storage period are presented in Table XVIII and Figure 6b. Data obtained from all the three storage devices (stainless steel container, polythene bag and gunny bag) is also given for comparison.

TABLE XVIII

EFFECT OF BOTANICALS ON THE WEEVILIZATION PERCENTAGE OF SELECTED PULSES AT THE END OF SIXTH MONTH

Pulses		Initial	*Azadirachta indica* (Neem)				*Vitex nigundo* (Nochi)				*Pongamia pinnata* (Pongamiya)				Control
			10g	15g	20g	25g	10g	15g	20g	25g	10g	15g	20g	25g	
Black Gram	SS	Nil	3.3	3.0	2.8	2.7	4.0	3.8	3.2	3.2	4.2	3.9	3.5	3.5	14.8
	PB	Nil	3.4	3.1	2.8	2.8	4.1	3.8	3.5	3.4	4.2	3.8	3.7	3.7	15.6
	GB	Nil	3.4	3.2	2.8	2.8	4.2	3.9	3.5	3.5	4.2	3.8	3.8	3.8	15.8
Black Channa	SS	Nil	3.0	2.9	2.2	2.2	3.4	3.3	3.0	3.0	3.5	3.4	3.2	3.2	10.5
	PB	Nil	3.1	3.0	2.2	2.2	3.5	3.5	3.1	3.1	3.6	3.5	3.3	3.2	11.2
	GB	Nil	3.1	3.0	2.5	2.4	3.6	3.5	3.2	3.2	3.7	3.5	3.3	3.3	11.5
Cowpea	SS	Nil	2.8	2.7	2.5	2.5	3.0	2.9	2.8	2.8	3.1	3.0	2.9	2.8	11.4
	PB	Nil	2.9	2.8	2.6	2.6	3.1	3.0	2.9	2.8	3.2	3.1	2.9	2.9	12.5
	GB	Nil	3.0	2.9	2.6	2.6	3.1	3.0	2.9	2.9	3.2	3.1	3.0	3.0	12.8
Green Gram	SS	Nil	3.6	3.3	3.0	3.0	3.8	3.7	3.4	3.4	3.9	3.6	3.5	3.4	18.7
	PB	Nil	3.7	3.4	3.1	3.1	3.8	3.8	3.5	3.4	3.9	3.7	3.5	3.5	18.8
	GB	Nil	3.6	3.4	3.2	3.2	3.8	3.7	3.5	3.5	3.9	3.8	3.6	3.6	18.9
Peas	SS	Nil	2.6	2.5	2.2	2.2	2.8	2.6	2.4	2.4	2.9	2.8	2.5	2.4	9.8
	PB	Nil	2.6	2.6	2.2	2.2	2.8	2.7	2.4	2.5	2.9	2.9	2.5	2.5	10.2
	GB	Nil	2.7	2.6	2.3	2.2	2.9	2.8	2.5	2.5	3.0	2.9	2.6	2.6	10.5

SS – Stainless steel container PB – Polythene bag GB – Gunny bag

The Bureau of Indian Standards (BIS) has marked the maximum level of weevilization in pulses as three per cent. Black channa, cowpea and peas stored with botanicals maintained the standard for weevilization upto six months. With regard to black gram and green gram stored with botanicals among all the variations maintained the standard recommended by BIS mark upto five months. But control group pulses maintained standard BIS indicated by only for 2 months. The same trend was observed in gunny and polythene bag as well. The detailed weevilization percentage for every month is given in Appendix X.

At the end of the 6th month, the weevilization was less (2.7%) in Black gram stored with neem leaf powder followed by nochi (3.2%) and pongamiya (3.5%). The similar trend was observed in all other selected pulses. Irrespective of the storage devices used, weevilization was efficiently controlled in pulses stored with neem followed by nochi and pongamiya leaf powders. It was also observed from the experiment that, as storage time increased, the weevilization percentage also slightly increased concurrently.

It was also noted that among the four variations - 10,15,20,25 g/kg of *Azadirachta indica* (neem), *Vitex nigundo* (nochi) and *Pongamia pinnata* (pongamiya) leaf powders, 20 and 25 g/kg of these botanical leaf powders proved to be efficient on moisture control and weevilization control for 1 kg of pulses. Dubey *et al.,* 2008 also reported in their study that increased concentration of botanical leaf powders will help to improve the insecticidal property to control food grain losses during storage.

4. Effect of botanicals on average weevilization percentage of selected stored pulses

The effect of botanicals on the average weevilization percentage of selected pulses at the end of 6th month of storage in three different storage devices are furnished in Table XIX.

TABLE XIX

AVERAGE WEEVILIZATION PERCENTAGE OF SELECTED STORED PULSES

Botanicals	Weevilization Percentage				
	Black Gram	Black Channa	Cowpea	Green Gram	Peas
$Neem_{10}$	3.4	3.1	2.9	3.6	2.6
$Neem_{15}$	3.1	3.0	2.8	3.4	2.6
$Neem_{20}$	2.8	2.3	2.6	3.1	2.2
$Neem_{25}$	2.8	2.3	2.6	3.1	2.2
$Nochi_{10}$	4.1	3.5	3.1	3.5	2.8
$Nochi_{15}$	3.8	3.4	3.0	3.8	2.7
$Nochi_{20}$	3.4	3.1	2.9	3.6	2.4
$Nochi_{25}$	3.4	3.1	2.8	3.4	2.5
$Pongamiya_{10}$	4.2	3.6	3.2	3.7	2.9
$Pongamiya_{15}$	3.8	3.5	3.1	3.8	2.9
$Pongamiya_{20}$	3.7	3.3	2.9	3.6	2.5
$Pongamiya_{25}$	3.7	3.2	2.9	3.5	2.5
Control	15.4	11.1	12.2	18.8	10.2
SE_D	0.14	0.13	0.17	0.13	0.09
CD(5%)	0.29	0.28	0.36	0.28	0.19
CD(1%)	0.40**	0.38**	0.48**	0.38**	0.26**

SE_D – Standard error of the difference

CD – Critical difference

It was observed that the effect of different botanicals namely *Azadirachta indica* (Neem), *Vitex nigundo* (Nochi) and *Pongamia Pinnata* (Pongamia) in different variations such as 10g, 15g, 25g and 25g on controlling weevilization percentage were highly significant in all the above selected pulses over the control group

(Detailed ANOVA results are presented in Appendix XI). It was also observed that the weevilization percentage is higher in control group when compared to pulses stored with botanicals among all the five selected pulses. These results are in tune with findings by Haq *et al.,* (2005), who showed that pulverized leaves of *Azadirachta indica* was effective against *T. castaneum.* They were also found to be seed protective as the spoilage of seeds were reduced to a significant extent. Epidi and Odili (2009) have also shown similar results with pulverized plant parts of *Telferia occidentalis, Zingiber officianale, Vitex grandifolia* and *Dracaena arborea* (Willd) against insect pests and recommended such post harvest treatments on stored groundnuts (*Arachis hypogaea* L.).

In black gram, the effect of the neem with 20g and 25g variations on weevilization percentage was highly significant over other botanical variations and control group during storage period. The weevilization percentage in pulses stored with neem at 20 and 25 g were 2.8 per cent and in control group, it was found to be 15.4 per cent. It was also observed that the difference in reduction of average weevilization percentage of pulses stored with neem at 20 and 25g was 12.6 per cent over the control group.

Similar result was observed in all other selected pulses. The average weevilization percentage in black channa, cowpea, green gram and peas stored with neem at 20 and 25 g were 2.3, 2.6, 3.1 and 2.2 per cent respectively and in control group, the same was observed to be 11.1, 12.2, 18.8 and 10.2 per cent respectively. These findings are on par with the study conducted by Rani and Mohan (2007). They also indicated the highest storage loss estimated in black gram followed by green gram and cowpea.

5. Effect of botanicals on germination percentage of selected pulses at the end of sixth month

Details on germination percentage of the selected stored pulses in the initial period and at the end of sixth month of storage period are presented in Table XIX and Figure 6c. Changes observed in all the three storage devices (stainless steel container, polythene bag and gunny bag) are also given for comparison.

TABLE XX

EFFECT OF BOTANICALS ON THE GERMINATION PERCENTAGE OF SELECTED PULSES AT THE END OF SIXTH MONTH

Pulses		Initial	*Azadirachta indica* (Neem)				*Vitex nigundo* (Nochi)				*Pongamia pinnata* (Pongamiya)				Control
			10g	15g	20g	25g	10g	15g	20g	25g	10g	15g	20g	25g	
Black Gram	SS	100	96	96	97	98	92	93	94	95	91	90	91	93	58
	PB	100	93	93	95	96	90	92	94	95	90	91	92	92	55
	GB	100	90	90	91	91	88	76	89	90	85	85	88	89	52
Black Channa	SS	100	93	95	94	95	91	91	90	90	88	90	92	92	51
	PB	100	84	85	87	88	80	81	84	85	81	82	84	84	45
	GB	100	82	82	84	85	78	80	81	82	78	79	82	82	44
Cowpea	SS	100	98	99	98	99	95	96	98	98	94	95	95	96	55
	PB	100	87	87	89	89	83	84	86	87	84	85	87	88	55
	GB	100	86	87	89	89	82	84	86	86	83	84	87	87	52
Green Gram	SS	100	96	98	98	99	95	95	96	97	93	94	95	95	64
	PB	100	88	90	91	92	85	88	90	90	86	88	89	89	62
	GB	100	85	86	88	89	83	85	86	87	84	86	86	88	60
Peas	SS	100	82	84	84	86	78	80	82	82	78	79	82	81	50
	PB	100	80	83	84	84	78	79	81	81	75	78	80	80	48
	GB	100	78	79	80	83	76	78	79	80	74	76	78	78	45

SS – Stainless steel container PB – Polythene bag GB – Gunny bag

The initial germination was hundred per cent in all the selected pulses. Eventhough the germination was hundred percent in all the selected pulses, black channa and peas showed germination only on the 7th day of seedling while the other pulses namely black gram, green gram and cowpea showed germination on the 5th day of seedling. Only 50 per cent of germination was observed in control group pulses at the sixth month of storage period. The experimental group pulses showed higher germination percentage when compared to control group pulses. The reason for lower germination rate in the control group pulses might be attributed to the fact that they are more infested and likely to affect germination unlike the experimental group pulses which were stored with botanicals. According to Ipsitaet *et al*., (2013) Infestation causes reduced seed germination, increase in moisture and decrease protein contents etc. resulting in total quality loss. Quality losses affect the economic value of the food grains fetching low prices to farmers. The botanicals even at the rate of 10 grams proved to show higher germination percentage in all varieties of pulses when compared to control group pulses. The detailed germination percentage for a period of six months are given in Appendix XII. Plate 16 shows the germination of selected stored pulses.

Containers selected

Sowing seeds

After 3 days

After 7 days

Plants

Plate 16

Germination of Selected Pulses

6. Effect of different botanicals on average germination percentage of selected stored pulses

The results of the study on the effect of different botanicals on the average germination percentage of selected stored pulses (stored in airtight stainless steel container, polythene bag and gunny bag) at the sixth month of storage period are furnished in Table XXI.

TABLE XXI

AVERAGE GERMINATION PERCENTAGE OF SELECTED STORED PULSES

Botanicals	Germination Percentage				
	Black Gram	Black Channa	Cowpea	Green Gram	Peas
$Neem_{10}$	93	86	90	90	80
$Neem_{15}$	93	87	91	91	82
$Neem_{20}$	94	88	91	92	83
$Neem_{25}$	95	89	92	93	84
$Nochi_{10}$	90	83	87	88	77
$Nochi_{15}$	87	84	88	89	79
$Nochi_{20}$	92	85	90	90	80
$Nochi_{25}$	93	86	90	91	82
$Pongamiya_{10}$	89	82	87	88	76
$Pongamiya_{15}$	89	84	88	89	78
$Pongamiya_{20}$	90	86	89	90	80
$Pongamiya_{25}$	91	86	90	91	80
Control	55	47	54	62	48
SE_D	3.17	4.44	4.96	4.12	1.50
CD(5%)	6.52	9.14	10.19	8.48	3.08
CD(1%)	8.81**	12.35**	13.78**	11.47**	4.17**

SE_D – Standard error of the difference

CD – Critical difference

It was observed that the effect of different botanicals namely *Azadirachta indica* (Neem), *Vitex nigundo* (Nochi) and *Pongamia Pinnata* (Pongamia) in different variations such as 10g, 15g, 25g and 25g on the germination percentage were highly significant in all the above selected compared to the control group (ANOVA results are presented in Appendix XIII).

In black gram, the effect of neem at 25g variation was highly significant over other botanical variations and control group with regard to germination percentage being observed during storage period. The average germination percentage of pulses stored with neem at 25 g variation was 95 per cent and in control group, the same was observed to be 55 per cent. It was also observed that the difference in average increment in germination percentage of pulses stored with neem at 20 and 25g variation was 40 per cent over the control group. The same was observed in all the other selected pulses.

At the end of sixth month storage period, pulses in control group showed germination at the rate of 55,47,54,62 and 48 per cent in the pulses namely black gram, black channa, cowpea, green gram and peas respectively. The experimental group pulses showed higher germination percentage when compared to control group pulses. The reason for lower germination rate in the control group pulses might be attributed to the fact that they are more infested that are likely to affect the innate germination efficacy of pulses unlike the experimental group pulses which were stored with botanicals. Devkumar (2005) also revealed in his research that neem treated seed showed no adverse effect on germination.

With regard to the storage devices, air tight stainless steel container proved to be efficient in terms of moisture control, weevilization control and in showing improved germination percentage compared to gunny and polythene bags. The findings of the present study are similar to the conclusions of the study conducted by Thomas *et al.*, (1985), Ministry of Food and Agriculture. They pointed out that food grains can be stored in air tight stainless steel container for a long period without being infested with insects and also even if infested grain is stored, insects do not breed but ultimately die in air tight container. Hayma (2003) also reiterates that the dried product will take up moisture from the more humid air during storage, unless it is stored in airtight and waterproof conditions.

Compared to gunny bags, polythene bags are good to store pulses since gunny bags are prone to free air movement and thus the moisture level might fluctuate which would further end up with insect and pest attack.

7. Average organoleptic quality of the prepared dishes stored with botanicals

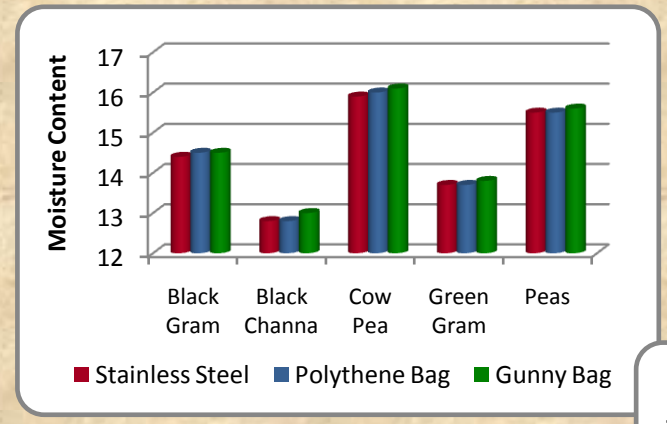
The effects of botanicals on organoleptic qualities of selected stored pulses at the sixth month of storage period are furnished in Table XXII and Figure 6d. The prepared recipes are shown in Plate 17.

TABLE XXII

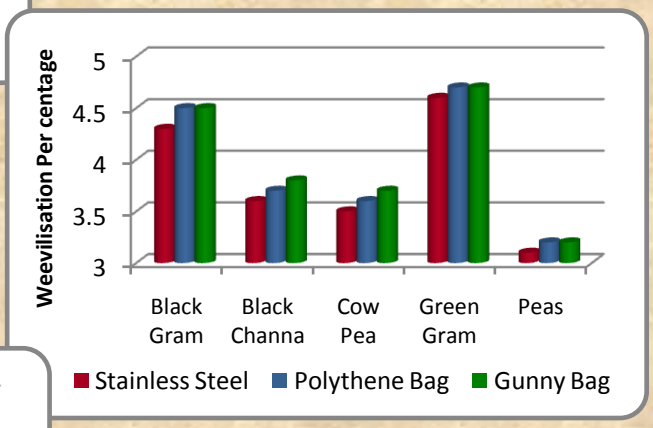
AVERAGE ORGANOLEPTIC QUALITY OF PREPARED DISHES STORED WITH BOTANICALS

Effect of botanicals on organoleptic quality of the prepared dishes				
Name of the pulses	**Final**			
	VARIATIONS (in grams)			
	10	**15**	**20**	**25**
Black Gram Vadai				
Neem	4	4	4	4
Nochi	4	3	4	4
Pongamiya	3	4	4	4
Control	3			
Black Channa Sundal				
Neem	3	4	4	4
Nochi	3	3	4	4
Pongamiya	3	3	3	3
Control	2			
Cowpea Gravy				
Neem	4	4	4	3
Nochi	4	4	4	3
Pongamiya	3	3	4	4
Control	3			
Green Gram Sundal				
Neem	4	4	4	3
Nochi	4	4	4	4
Pongamiya	4	3	3	4
Control	2			
Peas Sundal				
Neem	4	4	4	4
Nochi	3	4	4	3
Pongamiya	4	3	3	3
Control	2			

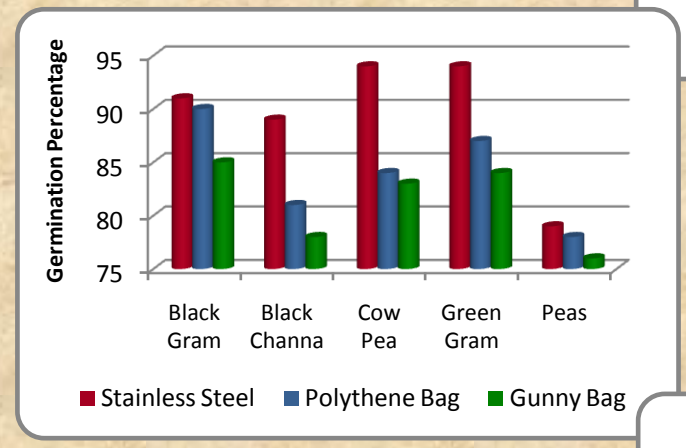
1-Poor, 2- Fair, 3- Good, 4- Very Good and 5- Excellent



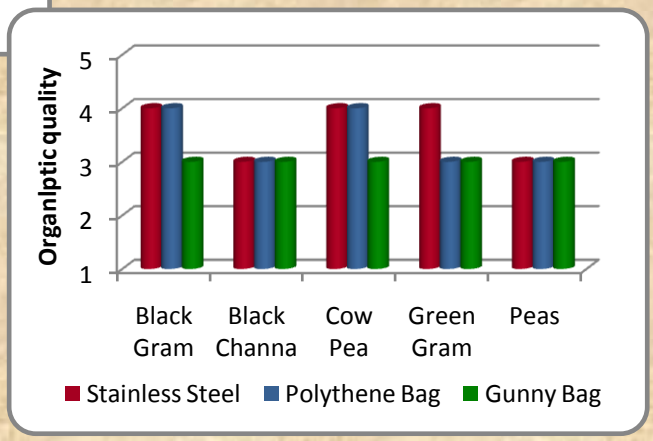
Moisture Content (6a)



Weevilization Percentage (6b)



Germination Percentage (6c)



Organoleptic Quality (6d)

Figure 6

Effect of Storage Devices on the Keeping Quality of Selected Pulses

Black channa sundal

Black gram vadai

Green gram sundal

Peas sundal

Cowpea gravy

Plate 17

Recipes Prepared Using Stored Pulses

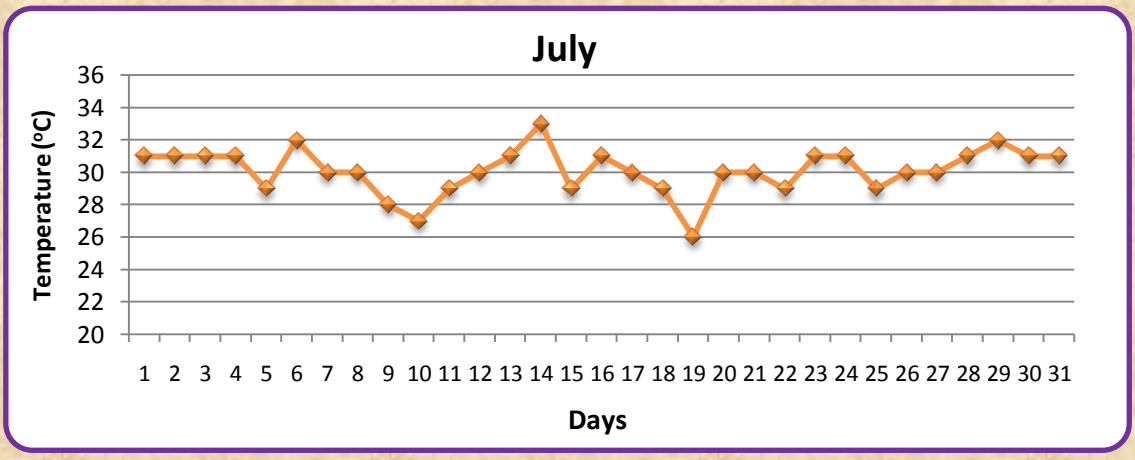
The organoleptic qualities of the recipes prepared out of experimental (at four variations of botanical leaves and proportions) and control group pulses were found to be excellent during its initial storage period. At the end of the storage period (6^{th} month), the organoleptic qualities of the recipes such as black channa sundal, green gram sundal and peas sundal were rated fair in control group while rated as good and very good among the pulses stored in three different botanicals with four variations. The reason for fair rated organoleptic quality of recipes of control group pulses might be attributed to damages caused due to insect and pest when compared to pulses stored with botanicals. Similar results were also observed in pulses stored in gunny and polythene bags.

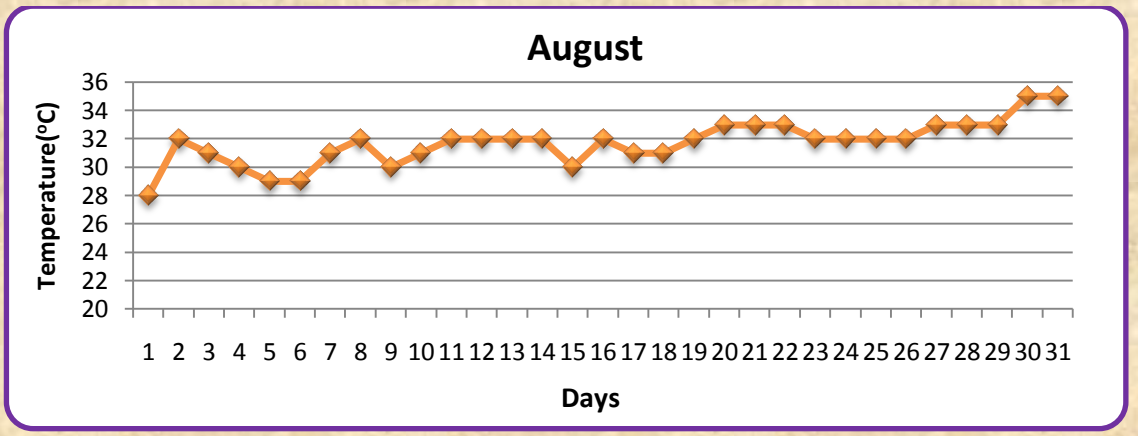
8. Ambient Room Temperature during the study period

Temperature plays an important role in storage life of pulses. Insects and moulds increase as temperature increases. The higher the moisture content of the pulses, the more they are adversely affected by temperature. The survival and reproduction of biological agents in grain is dependent largely on the temperature and moisture levels (White, 2001 and Wilson, 2013).

High temperatures during storage, limit the storage period. Storage period varies with respect to grain moisture content and the temperature. The stored products, as well as the organisms attacking stored products are living things: they breathe. During respiration, oxygen is used up and carbon dioxide, water and heat are produced. The rate of respiration, and thus the amount of carbon dioxide, water and heat that are produced is strongly dependent on the temperature and the moisture content of the product. The rate of respiration is reduced approximately by one half for each 10°C reduction in temperature (Hayma, 2003). According to Lal and Verma (2007) the best way to increase the keeping quality of stored pulses is to lower the temperature. For every decrease of 5^{o}C in storage temperature, the life of the pulses doubles. This rule applies between 0^{o}C to 50^{o}C.

The temperature during the study period (July 2012 – December 2012) was measured using sensitive thermometer and the data obtained is presented as graphical representation in Figure 7.





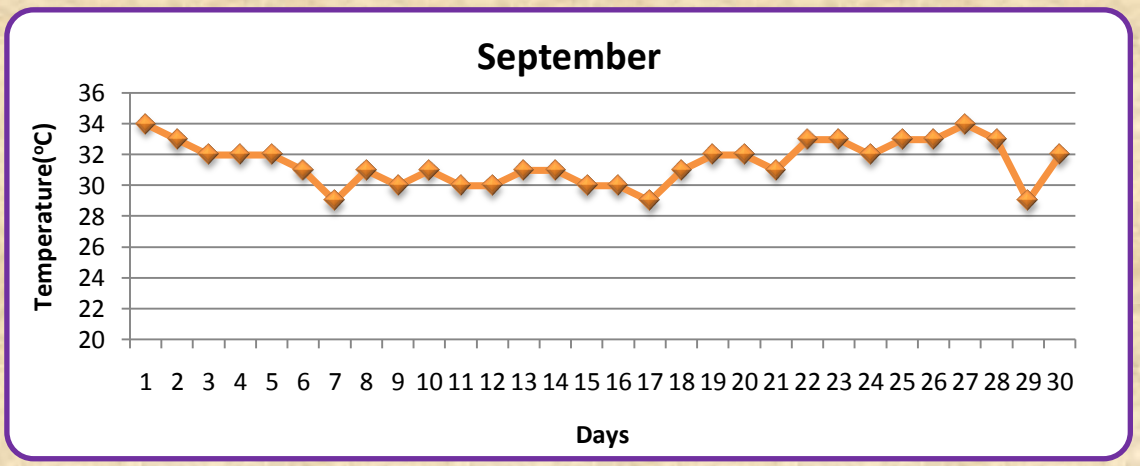
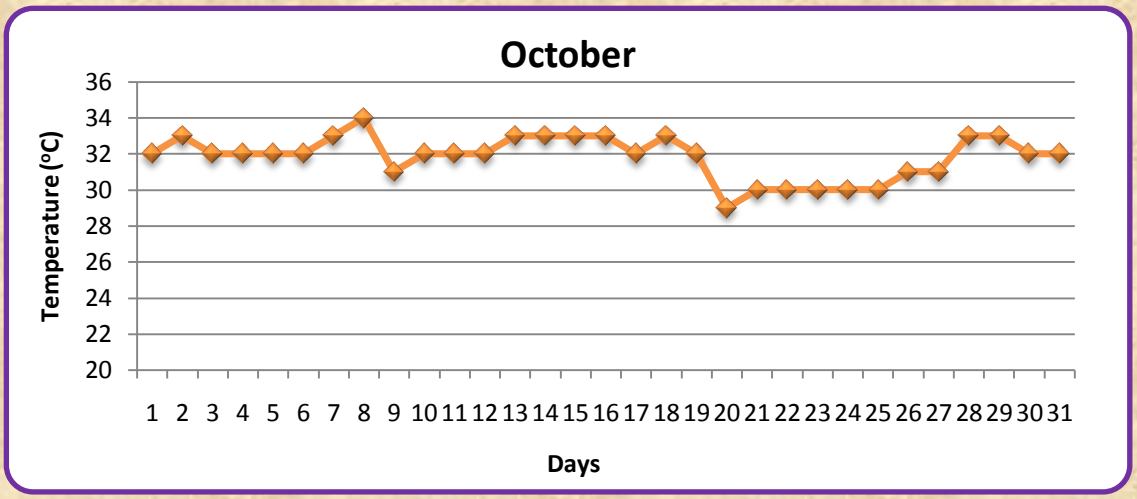
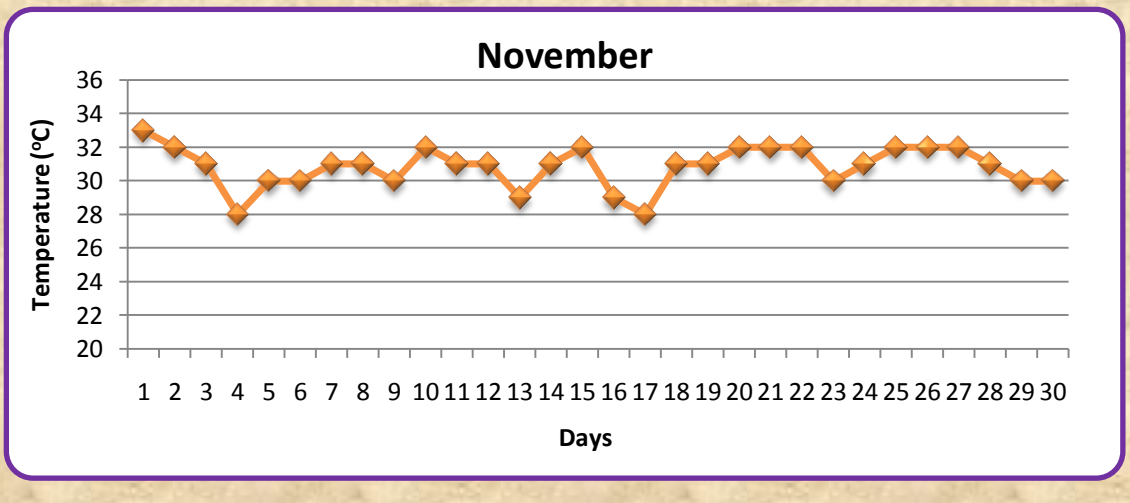


Figure 7

Temperature (^{o}C) during the study period





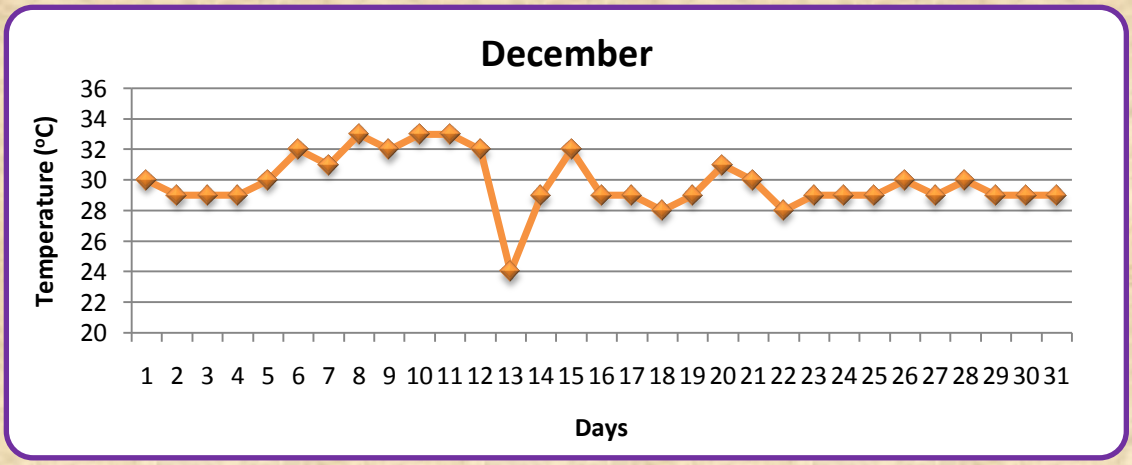


Figure 7 (Contd…)

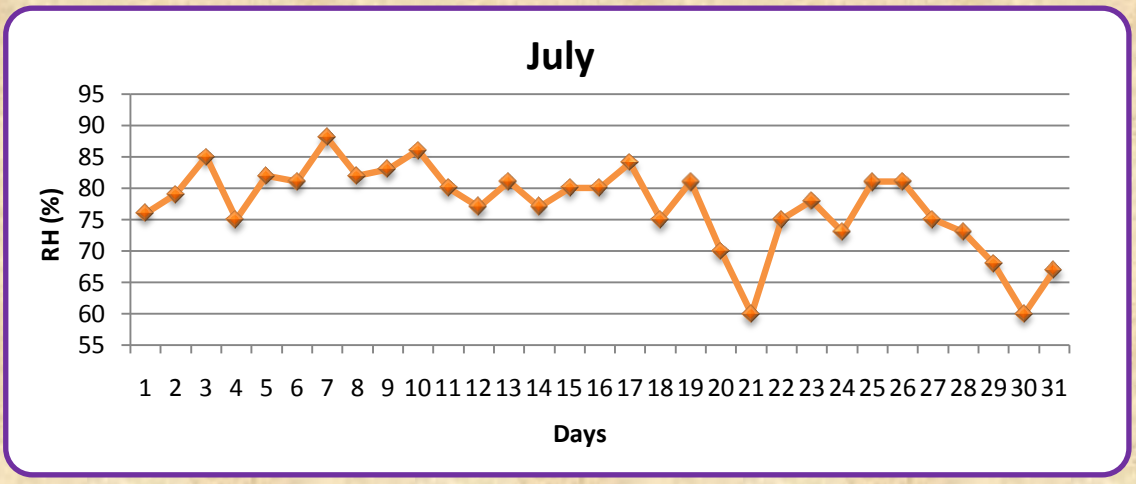
Temperature (^{o}C) during the study period

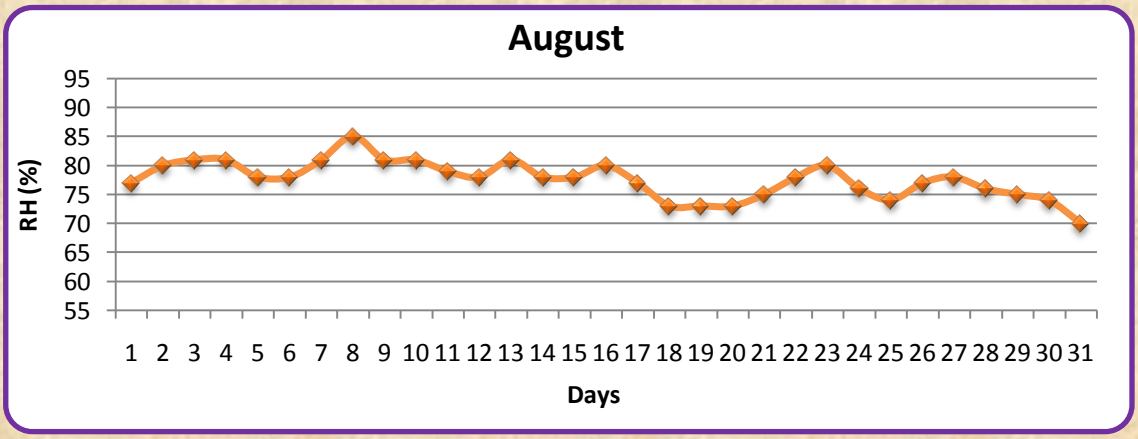
The Figure 7 clearly reveals that the minimum temperature observed during the study period (1st July to 31st December 2012) was in the month of December i.e. 24°C while the maximum temperature of 35 °C was observed in the month of August. During this study period the temperature varied between 24°C to 35°C which is favourable for the survival of insects and that was the main reason for higher weevilization percentage during trial experiment in control group pulses. Temperature plays an important role in the development of insect pest (weevilization) during storage of pulses. According to Illelyi *et al*., (2007) for most stored-product pests, the lower developmental threshold is approximately 18°C and the optimum development range is approximately 25-35°C. Decreasing temperature during storage is an effective means to maintain keeping quality of pulses. Temperature management is one of the most promising insect management tool. But it is not possible to control temperature in day to day household storage environment.

9. Relative Humidity during the study period

Relative Humidity during the study period was obtained from Agro Climate Research Centre, Tamil Nadu Agricultural University, Coimbatore and presented in Figure 8 as graphical representation. Relative humidity is the amount of water present in the air at a given temperature in proportion to its maximum water holding capacity. As relative humidity increases the moisture content also increases concurrently. Temperature is indirectly proportional to moisture content and relative humidity. Relative humidity and temperature are the most important factors determining the keeping quality of pulses.

From the following graph it is clear that, a maximum difference in the relative humidity was observed only in the month of December during the study period of 6 months. It was also noted from the detailed weevilization table (Appendix X) that maximum weevilization percentage and moisture content was observed in the month of December in all the selected five pulses. It may be due to differences in relative humidity. The moisture content of pulses also increased due to increases in relative humidity. Wide variation in moisture content was observed in all the six months of storage period July (60-88%), August (73%-85%), September (68%-89%), October (65%-86%), November (60%-87%) and December (56%-91%).





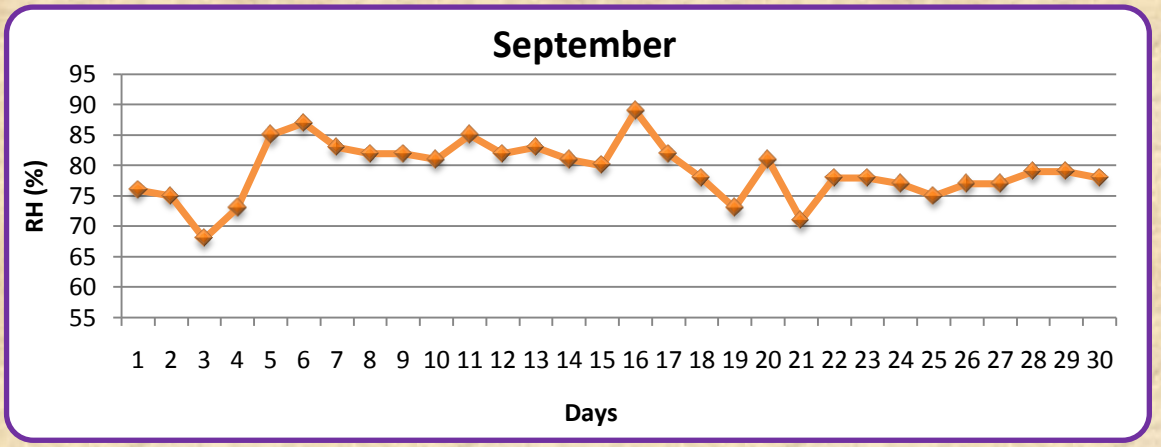
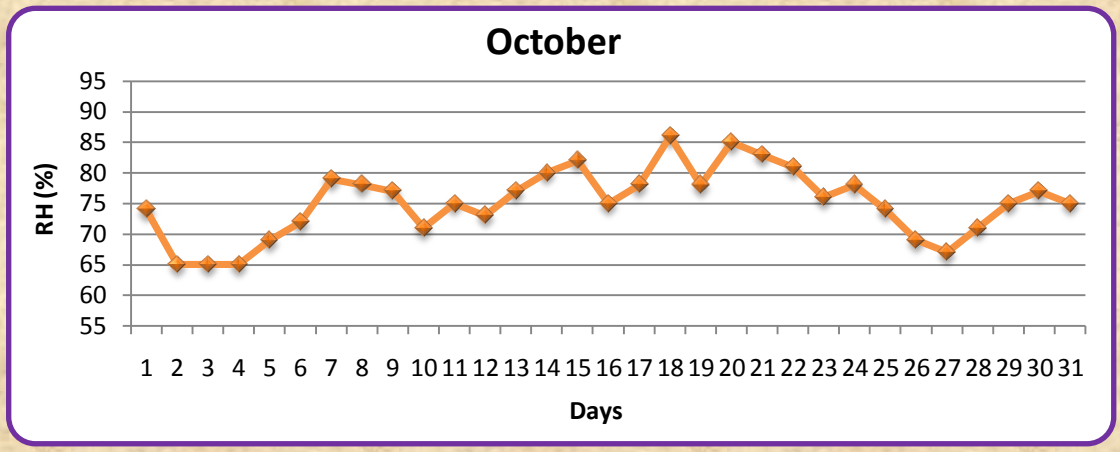
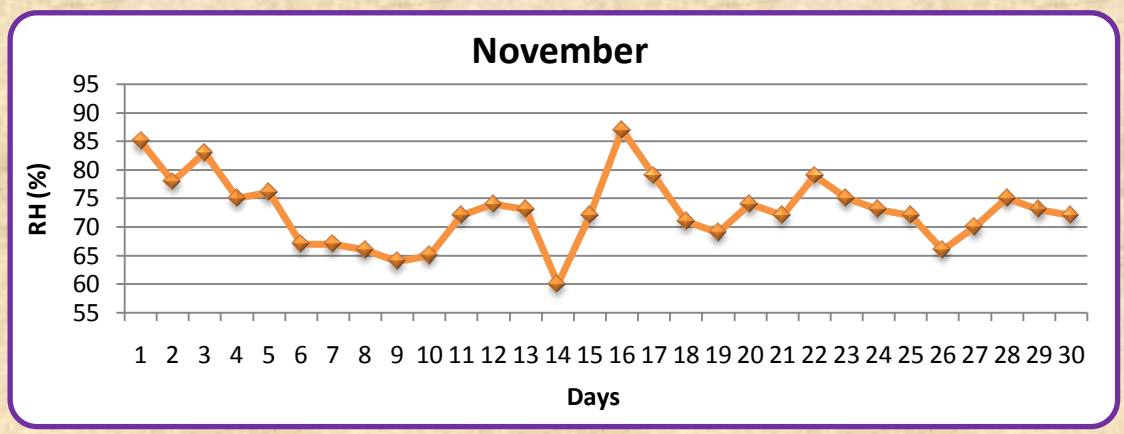


Figure 8

Relative Humidity (%) during the study period





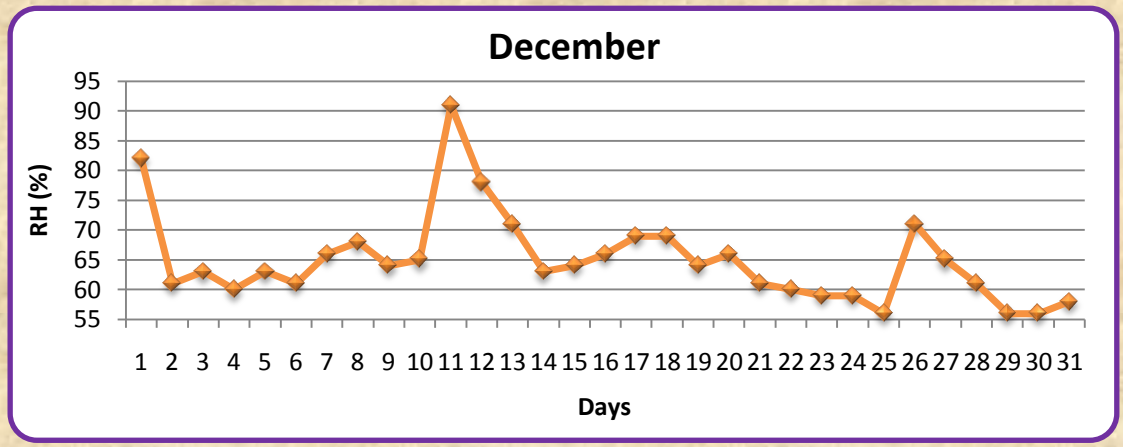


Figure 8 (Contd…)

Relative Humidity (%) during the study period

During the study period, relative humidity varied between 56-91% and that is the most favorable development range for insect and pest infestation during storage. These results are concurring with Mullen and Arbogast (1979) study. They concluded that stored-pulses insects can live at temperatures from 8 to 41°C and inter-granular relative humidities from 1% to 99%.

Even though the temperature and relative humidity was favourable for the development of insect and pest in stored pulses during trial experiment, pulses stored with botanicals maintained safe moisture level and weevilization percentage was also upto BIS mark.

Hypothesis

Storing pulses with selected botanicals does not help in retaining the keeping quality of pulses

It could be concluded from the above results (tables XVI, XVII, XVIII, XIX, XX, XXI) of moisture, weevilization, germination and organoleptic qualities, that leaves of *Azadirachta indica* (Neem), *Vitex nigundo* (Nochi) and *Pongamia Pinnata* (Pongamia) have insecticidal properties against the insect and pests of stored pulses and helped in retaining the keeping quality of pulses. Even though temperature and relative humidity was favourable for insects and pest attack, during the storage period from July- December, all botanical and its variations maintained the safe level of moisture content upto six months in black gram, black channa and green gram and upto three months in cowpea and pea. The weevilization percentage also was upto BIS mark in the pulses stored with neem leaf powder. **Hence, the hypothesis is rejected**. It could be proved that storing pulses with selected botanicals will definitely help in retaining the keeping quality of pulses.

C. Impact of the training programme on the use of botanicals during storage of pulses

"Adoption rate of complex technology is very high why not our ancient practices, may be because it is not shared and explained. So importance of training is necessary in making it more effective through a wide scale acceptance".

The impact of the training programme on the use of botanicals during pulses storage on the selected homemakers and shop keepers were assessed in terms of the following,

1. Association between the levels of knowledge, attitude, and adoption and socio- demographic variables of the selected homemakers after training programme
2. Association between the levels of knowledge, attitude, and adoption and socio- demographic variables of the selected shop keepers after training programme
3. Homemakers' knowledge score on the use of botanicals during storage before and after training programme.
4. Homemakers' attitude towards the use of botanicals during storage of pulses before and after training programme.
5. Level of adoption towards the use of botanicals during storage of pulses before and after training programme by the selected households.
6. Shop keepers' knowledge score towards the use of botanicals during storage of pulses before and after training programme.
7. Shop keepers' attitude towards the use of botanicals during storage of pulses before and after training programme.
8. Level of Adoption of using botanicals by the shop keepers during storage of pulses before and after training programme by the shop keepers.
9. Percentage of losses of pulses before and after training programme.
10. Quantum of pulses saved through adoption of using botanicals during storage and its monetary benefits.
11. Opinion regarding the adoption of botanicals during storage of pulses by homemakers and shop keepers.
12. Suggestions for better adoption on using botanicals in storage by homemakers and shop keepers.

1. Association between the levels of knowledge, attitude, and adoption and socio- demographic variables of the selected homemakers after training programme

It is essential to understand the socio economic profile of the selected families and their knowledge, attitude and adoption score by socio-demographic variables. The distribution of homemakers with respect to socio-economic characteristics such

as age, type of family, size of family, stages in family life cycle, monthly income, educational qualification and knowledge, attitude and adoption score by socio-demographic variables are presented in Table XXIII

TABLE XXIII

ASSOCIATION BETWEEN THE LEVELS OF KNOWLEDGE, ATTITUDE, AND ADOPTION AND SOCIO- DEMOGRAPHIC VARIABLES OF HOMEMAKERS

N=300

Socio-economic variable	Particulars	No of trainees	%	Knowledge χ^2 – Value	Attitude χ^2 - Value	Adoption χ^2 - Value
Age	below 30 years	50	17	0.116^{NS} (12.59)	2.495^{NS} (12.59)	1.763^{NS} (12.59)
	30 - 40 years	116	39			
	40 - 50 years	96	32			
	above 50 years	38	12			
Type of family	joint family	115	38	0.872^{NS} (5.99)	0.422^{NS} (5.99)	3.806^{*} (5.99)
	nuclear family	185	62			
Size of family	small family	85	28	1.435^{NS} (9.49)	1.693^{NS} (9.49)	11.128^{**} (9.49)
	medium family	164	55			
	large family	51	17			
Stages in family life cycle	beginning family	62	21	1.458^{NS} (9.49)	0.639^{NS} (9.49)	0.253^{NS} (9.49)
	expending family	170	57			
	contracting family	68	22			
Monthly income (HUDCO)	Low (`.2500-4500)	75	25	1.363^{NS} (9.49)	0.497^{NS} (9.49)	2.948^{NS} (9.49)
	Middle (`. 4501-7500)	180	60			
	High (Above `. 7501)	45	15			
Educational qualification	illiterate	67	22	6.848^{NS} (12.59)	2.483^{NS} (12.59)	1.625^{NS} (12.59)
	primary	124	41			
	secondary	68	23			
	higher secondary	41	14			
	graduate	-	-			

NS – Non significant, ** - significant at 1% level, * - significant at 5%level.

The values within the parenthesis indicate the table χ^2 value at 5% level of significance.

Thirty nine percent of the homemakers selected for the training programme belonged to the age group of 30-40 years, while 32 per cent were 40-50 years. The percentage of nuclear family system was high (62%) and the joint family system was low (38%) among the selected homemakers for training programme. With regard to family size, fifty five per cent of homemakers belonged to medium size family while 28 and 17 per cent were grouped under small and large family size respectively. Fifty seven percent of homemakers were in expanding stage of family life cycle and 60 percent belonged to middle income group. Since 78 per cent of homemakers were literates, it facilitated easy understanding of the concept taught. Only 22 per cent of the homemakers were illiterate.

Hypothesis

There is no significant association between the levels of knowledge, attitude and adoption and demographic variables of homemakers.

It could be inferred from the above table chi-square analysis, that except in the case of variable – type of family (adoption score difference was significant at one per cent level) and size of family (adoption score difference was significant at five per cent level) all the other variables such as age, monthly income, stages in family life cycle and educational status did not show any significant difference in knowledge, attitude and adoption score after the training programme. **Hence the hypothesis is partially accepted**.

2. Association between the levels of knowledge, attitude, and adoption and socio- demographic variables of the selected shop keepers after training programme

It is essential to understand the socio economic profile of the selected shop keepers and their knowledge, attitude and adoption score by socio-demographic variables. The distribution of shop keepers with respect to socio-economic characteristics such as age, type of family, size of family, stages in family life cycle, monthly income, educational qualification and knowledge, attitude and adoption score by socio-demographic variables are presented in table XIV.

TABLE XIV
ASSOCIATION BETWEEN THE LEVELS OF KNOWLEDGE, ATTITUDE, AND ADOPTION AND SOCIO- DEMOGRAPHIC VARIABLES OF SHOP KEEPERS

N=16

Socio-economic variable	Particulars	No of trainees	%	Knowledge χ^2 - Value	Attitude χ^2 - Value	Adoption χ^2 - Value
Age	below 30 years	4	25	3.73^{NS} (12.59)	7.68^{NS} (12.59)	3.20^{NS} (12.59)
	30-40 years	5	31			
	40 - 50 years	5	31			
	above 50 years	2	13			
Type of family	joint family	5	31	0.87^{NS} (5.99)	0.01^{NS} (5.99)	2.37^{NS} (5.99)
	nuclear family	11	69			
Size of family	small family	3	19	0.80^{NS} (9.49)	0.16^{NS} (9.49)	0.48^{NS} (9.49)
	medium family	11	69			
	large family	2	12			
Stages in family life cycle	beginning family	4	25	2.37^{NS} (9.49)	0.356^{NS} (9.49)	3.20^{NS} (9.49)
	expending family	9	56			
	contracting family	3	19			
Monthly income (HUDCO)	Low (` 2500-4500)	1	6	0.44^{NS} (9.49)	1.77^{NS} (9.49)	4.62^{NS} (9.49)
	Middle (`. 4501-7500)	12	75			
	High (Above `. 7501)	3	19			
Educational qualification	illiterate	3	19	5.33^{NS} (12.59)	6.75^{NS} (12.59)	1.77^{NS} (12.59)
	primary	5	31			
	secondary	6	38			
	higher secondary	2	12			

NS – Non significant, ** - significant at 1% level, * - significant at 5%level.

The values within the parenthesis indicate the table χ^2 value at 5% level of significance.

Thirty one per cent of shop keepers belonged to the age group of 40-50 years while 25 per cent of them were below 30 years of age. Sixty nine per cent of the selected shop keepers belonged to nuclear family and the rest were living in the traditional joint family system. Sixty nine percent of shop keepers belonged to medium size family while 19 and 12 per cent were small and large size family respectively. Fifty six per cent of shop keepers were in expanding stage of life cycle and only six per cent were in low income group category. Nearly 31 per cent, 38 per cent and 12 per cent of them had different levels of school education whereas only 19 per cent of them were illiterate.

Hypothesis

There is no significant association between the levels of knowledge, attitude and adoption and demographic variables of shop keepers.

It could be concluded from above table chi-square analysis that there is no significant difference in the knowledge, attitude and adoption score by socio-demographic variables such as age, type of family, size of family, stages in family life cycle, monthly income and educational status of shop keepers after the training programme. **Hence the hypothesis is accepted**.

3. Homemakers' knowledge score on the use of botanicals on storing pulses both before and after training programme

Knowledge is the total amount of information understood by an individual; it can be defined as a body of understood information as possessed by an individual. Training can change any person's cognitive learning which may result to gain in knowledge on the concept taught. The assessment of knowledge levels of homemakers' before and after training programme on the use of botanicals during storage is furnished in table XXV and Figure 9a.

TABLE XXV

HOMEMAKERS' KNOWLEDGE ON THE USE OF BOTANICALS BEFORE AND AFTER TRAINING PROGRAMME

N=300

Knowledge	Low No (%)	Moderate No (%)	High No (%)	Total No (%)	Mean	Standard Deviation	t value	P value
Before	126 (42)	174 (58)	-	300(100)	7.87	2.95	79.49**	p<0.01
After	-	199 (66)	101 (34)	300(100)	18.35	1.56		

**** Significant at 1 per cent level**

Knowledge schedule was prepared which included questions regarding the use of botanicals on pulses storage practices and the same was imparted to selected 300 homemakers. Before the training programme, 58 per cent of the homemakers were in moderate level of knowledge, and 42 per cent of them were categorized under low level of knowledge regarding usage of botanicals during storage of pulses. None of them showed high knowledge level before training programme.

Respondents having low level of knowledge regarding storage of pulses moved to moderate level of knowledge and those having moderate level of knowledge moved up to higher level of knowledge after training programme. Hence, 66 per cent of the homemakers showed moderate level and 34 per cent showed higher level of knowledge after the conduct of the training. None of them were in the category of low level of knowledge. It can be inferred from the result that the knowledge level of the homemakers improved after the training programme with respect to the use of botanicals in pulses storage.

Paired sample t-test was used to assess the knowledge scores before and after the training programme among homemakers. It was also observed that the difference of the average levels of knowledge before and after the training programme on storage practices of pulses was highly significant at 1% level. The training programme was highly effective to enhance the knowledge levels of homemakers on safe storage practices of pulses and the use of botanicals during storage.

4. Homemakers' attitude towards the use of botanicals during storage of pulses before and after training programme

Attitude is a predisposition or a tendency to respond positively or negatively towards a certain idea, situation or concept. Attitude influences an individual choice of action (http://www.businessdictionary.com/). Table XXVI and Figure 9b presents the assessment of attitude levels of the selected homemakers towards use of botanicals during storage of pulses before and after training programme.

TABLE XXVI

HOMEMAKERS' ATTITUDE TOWARDS THE USE OF BOTANICALS DURING STORAGE BEFORE AND AFTER TRAINING PROGRAMME

N=300

Attitude	Low No (%)	Moderate No (%)	High No (%)	Total No (%)	Mean	Standard Deviation	t value	p value
Before	141 (47)	159 (53)	-	300(100)	24.53	4.07	107.97**	p<0.01
After	-	174 (58)	126 (42)	300(100)	68.68	3.79		

**** Significant at 1 per cent level**

Before the training programme, forty seven per cent of the homemakers were had low level of attitude and 53 per cent of them had moderate level of attitude towards the use of botanicals for safe storage of pulses. None of them showed high attitude level. After the training programme, those who had low level moved to moderate and higher level. Hence, 58 per cent of the respondents showed moderate level and 42 per cent showed higher level of attitude. None of them was in the category of low level of attitude.

With regard to the average levels of attitude before and after training on the use of botanicals on storage period of pulses by the selected home makers were 24.53 and 68.68 with a standard deviation of 4.07 and 3.79 respectively. The calculated t-value is 107.97 which was higher than the table value of 2.58 at 1% level of significance. Since the calculated value is higher than the table value it could be inferred that the difference of the average levels of attitude before and after the

training programme on safe storage practices of pulses was highly significant at 1% level. The training programme was highly effective to increase the attitude levels of homemakers on the use of botanicals during storage of pulses.

5. Level of Adoption towards the use of botanicals during storage of pulses before and after training programme by the selected households

The assessment of adoption levels of homemakers before and after training programme on the use of botanicals during pulses storage is furnished in Table XXVII and Figure 9c.

TABLE XXVII

HOMEMAKERS' ADOPTION LEVEL OF USING BOTANICALS BEFORE AND AFTER TRAINING PROGRAMME

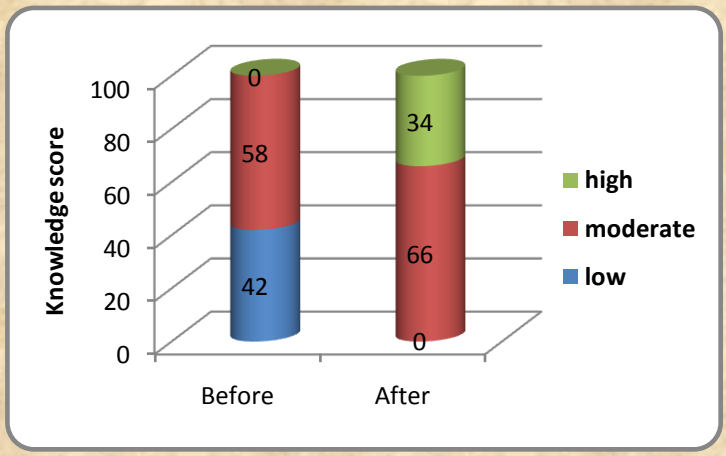
N=300

Adoption	Low No (%)	Moderate No (%)	High No (%)	Total No (%)	Mean	Standard Deviation	t value	p value
Before	202 (67)	98 (33)	-	300(100)	4.70	1.57	213.76**	p<0.01
After	-	6 (2)	294 (98)	300(100)	14.26	1.28		

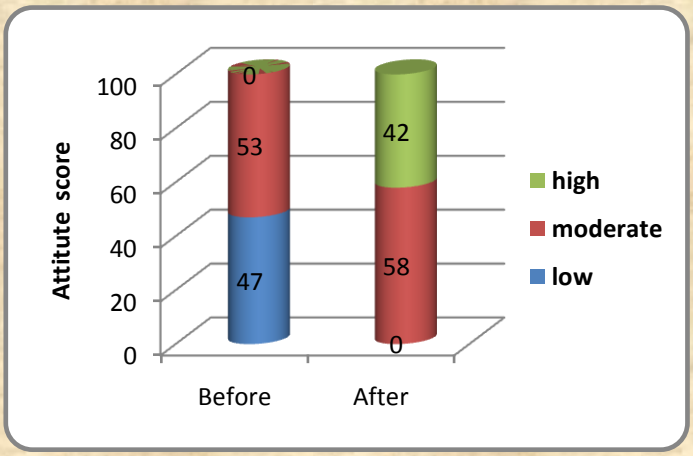
**** Significant at 1 per cent level**

Majority 67 per cent of the homemakers' adoption level was low before the training programme and they moved to moderate and higher level after the training programme. Thirty three per cent of them who were falling under category of moderate level improved their adoption level to the next higher level. None of them showed high attitude level before training. After the training programme, those who have low and moderate level moved to moderate (6%) and high level (98%) respectively. Hence the training programme had a positive impact on the adoption practices.

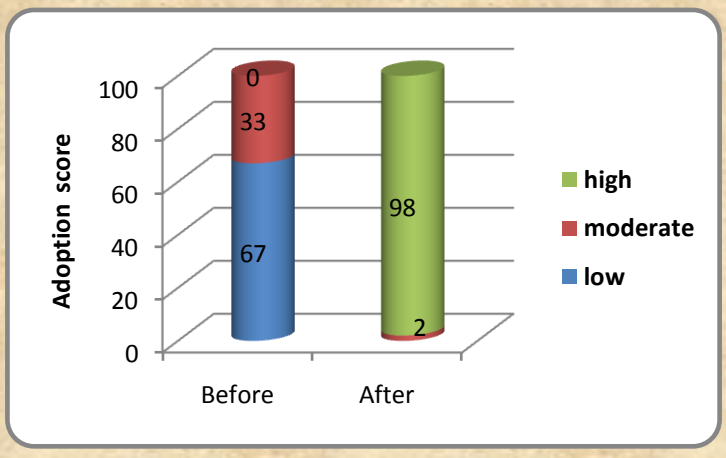
It was also observed that the difference of the average levels of adoption before and after training programme on storage practices of pulses was highly significant at 1% level. The training programme was highly effective to improve the adoption levels of homemakers on the use of botanicals during storage of pulses.



Knowledge (9a)



Attitude (9b)



Adoption (9c)

Figure 9

Knowledge, Attitude and Adoption Scores of the Homemakers Before and After Training Programme

6. Shop keepers' knowledge towards the use of botanicals during storage of pulses before and after training programme

The Table XXVIII and Figure 10a presents the knowledge of the selected shop keepers towards use of botanicals during storage of pulses before and after training programme.

TABLE XXVIII

SHOP KEEPERS' KNOWLEDGE TOWARDS THE USE OF BOTANICALS DURING STORAGE BEFORE AND AFTER TRAINING PROGRAMME

N=16

Knowledge	Low No (%)	Medium No (%)	High No (%)	Total No (%)	Mean	Standard Deviation	t-value	p- value
Before	10(63)	6(37)	-	16(100)	1.38	0.500	11.00**	p<0.01
After	-	4(25)	12(75)	16(100)	2.75	0.447		

**** Significant at 1 per cent level**

Before the training programme, 63 per cent of the shop keepers knowledge level was at low level. Thirty seven per cent of them had moderate level of knowledge. None of them showed high knowledge level. After the training programme, only 25 per cent of the shop keepers showed moderate level and 75 per cent showed higher level of knowledge.

The calculated t value is 11.0 which was higher than the table value 2.60 at 1% level of significance. Since the calculated value is higher than the table value it is inferred that the mean of knowledge scores differ significantly between before and after the training. The difference of the average levels of knowledge before and after the training programme on storage practices of pulses was highly significant.

7. Shop keepers' attitude towards the use of botanicals during storage of pulses before and after training programme

The table XXIX and Figure 10b presents the attitude of the selected shop keepers towards the use of botanicals during storage of pulses before and after training programme

TABLE XXIX

SHOP KEEPERS' ATTITUDE TOWARDS THE USE OF BOTANICALS DURING STORAGE BEFORE AND AFTER TRAINING PROGRAMME

N=16

Attitude	Low No (%)	Moderate No (%)	High No (%)	Total No (%)	Mean	Standard Deviation	t value	p value
Before	8(50)	8(50)	-	16(100)	1.50	0.516	10.08**	p<0.01
After	-	10(63)	6(37)	16(100)	2.38	0.500		

**** Significant at 1 per cent level**

Fifty per cent of the shop keepers' attitude level was low and moderate before training. None of their attitude showed a high level before the training programme. After the training programme, among those whose attitude level was low level moved to moderate (63%) and moderate level moved to higher level (37%) of attitude.

It was observed that the average level of attitude before and after training on use of botanicals during pulses storage period by shop keepers were 1.50 and 2.38 with a standard deviation of 0.516 and 0.500 respectively. The calculated t-value is 10.08 which was higher than the table value of 2.60 at 1% level of significance. Since the calculated value is higher than the table value it is inferred that the difference of the average levels of attitude before and after the training programme on storage practices of pulses was highly significant at 1% level. The training programme was highly effective to enhance the attitude levels of shop keepers' on the use of botanicals during storage of pulses.

8. Level of adoption of using botanicals by the shop keepers during storage of pulses before and after training programme

The Table XXX and Figure 10c presents the adoption level of the selected shop keepers with respect to use of botanicals during storage of pulses before and after training programme

TABLE XXX

LEVEL OF ADOPTION BY THE SHOP KEEPERS TOWARDS THE USE OF BOTANICALS DURING STORAGE

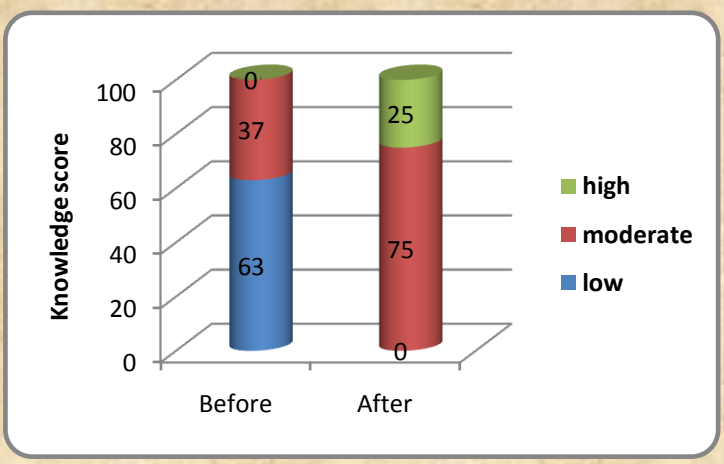
N=16

Adoption	Low No (%)	Moderate No (%)	High No (%)	Total No (%)	Mean	Standard Deviation	t- value	p-value
Before	10(63)	6(37)	-	16(100)	1.38	0.500	12.19**	p<0.01
After	-	1(6)	15(94)	16(100)	2.94	0.250		

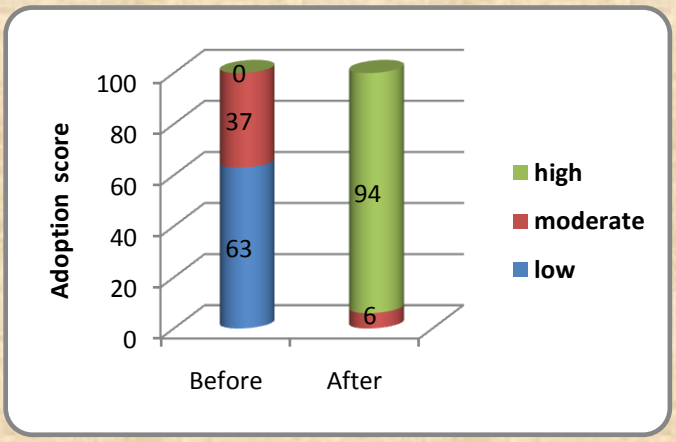
**** Significant at 1 per cent level**

Before the training programme, 37 per cent of the shop keepers were in the category of moderate level. Sixty three per cent of them fall under the category of low level of adoption regarding usage of botanicals during storage of pulses. None of them showed high adoption level before training programme. After the training programme, a majority of 94 per cent of the shop keepers showed high level of adoption in terms of using botanicals during pulses storage. It can be inferred from the result that the adoption level of the shop keepers improved after the training programme on the use of botanicals in pulses storage.

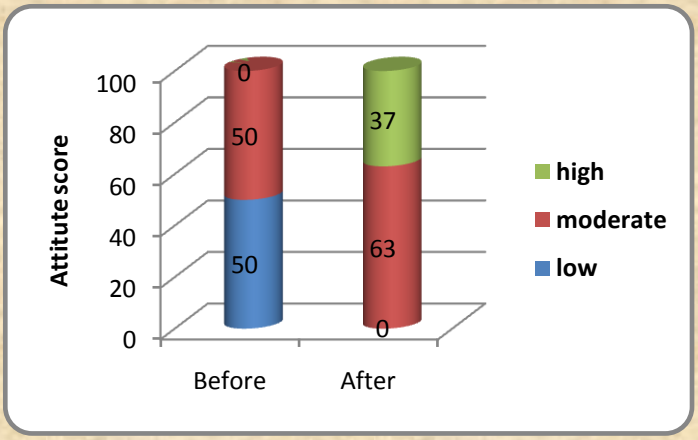
The calculated t-value is 12.19 which was higher than the table value of 2.60 at 1% level of significance. Since the calculated value is higher than the table value it is inferred that the difference of the average levels of adoption before and after the training programme on the use of botanicals during pulses storage was highly significant at 1% level. The training programme was highly effective to enhance the attitude levels of shop keepers' on the use of botanicals during storage of pulses.



Knowledge (10a)



Attitude (10b)



Adoption (10c)

Figure 10

Knowledge, Attitude and Adoption Scores of the Shop Keepers Before and After Training Programme

Hypothesis

Training on the use of different botanicals during pulses storage does not improve the knowledge and attitude of homemakers and shop keepers.

From the above results (Table XXV, XXVI, XXVIII, XXIX), it could be concluded that training on the use of different botanicals during pulses storage definitely improved the knowledge and attitude of homemakers and shop keepers. **Hence the hypothesis is rejected.**

9. Percentage of losses of pulses before and after training programme

After providing training on safe storage techniques for pulses, the homemakers and shop keepers were encouraged to adopt those practices effectively. With regard to the adoption level, cent per cent of home makers and shop keepers adopted the storage techniques and the use of botanicals during storage of pulses. The percentage of losses of pulses before (pre adoption stage) and after training programme (through adopting the method of using different botanicals) during storage of pulses was estimated based on the experience of homemakers and shop keepers through frequent visits and oral questions put forth by the investigator.

Percentage of loss on storage of pulses at the end of sixth month before and after adoption of safe storage techniques and use of botanicals during pulses storage as expressed by the homemakers is presented in Table XXXI.

TABLE - XXXI

LOSSES OF PULSES BEFORE AND AFTER ADOPTION OF BOTANICALS DURING STORAGE

S. No	Pulses	Percentage of losses (%)	
		Before	After
1	Black gram	12-14	2-4
2	Black channa	10-12	1-2
3	Cowpea	10-12	2-4
4	Green gram	14-16	4-6
5	Peas	10-12	1-2

It could be revealed from the above table that percentage of loss on storage of pulses at the end of sixth month is about 14-16 per cent and 12-14 per cent in green gram and black gram respectively. While 10 -12 per cent of loss was observed in black channa, cowpea and peas before the training programme.

After adopting the safe storage techniques and use of botanicals in storage, the percentage of loss was reduced drastically to 4-6 per cent in green gram and 2-4 per cent in cowpea and black gram. Only 1-2 percent of loss was observed in all other pulses. The homemakers and shop keepers felt that, majority of them were not aware of this storage methods and even though some of them were aware of usage of botanicals during storage, they were not adopted before training programme. They also expressed that, they can store their pulses for longer period of time without using chemicals by adopting this simple technique during storage.

It could be revealed from the above results that on an average 10 percent of storage losses can be minimized in household level itself by adopting the use of botanicals during storage of pulses. If the above method is followed in large scale storage, the losses can be minimized even more. In India, annual storage losses have been estimated as 14 million tonnes of worth of Rs. 7,000 crores. If the safe storage practices and use of botanicals during storage are followed in farm level, government godowns and warehouses, an enormous quantity of pulses can be saved from insect and pest damage which leads to the multiple benefits for years to come.

10. Quantum of pulses saved through adoption of using botanicals during storage and its monetary benefit

The quantum of pulses saved through adoption of safe storage practices and use of botanicals in storage and its monetary benefit obtained for six months storage period are presented in Table XXXII.

The below table highlights the average quantum of pulses saved and monetary benefits derived through adoption of safe storage practices and use of botanicals during storage in selected households. The quantity stored and money value of the pulses saved depends upon with the size of the family and their pulses consumption pattern. It could be inferred that approximately around 6 kgs of pulses was calculated to be

around Rs.572/- could be saved by the use of botanicals in storage. In addition to the monetary benefit reaped, improved hygiene and health benefit due to non use of insecticides is also highlights. While the value of saved pulses per household per storage period of 6 months is measured approximately to 572/-, savings for shop keepers who normally store multifold than the household storage runs into tens of thousands.

TABLE XXXII

AVERAGE QUANTUM OF PULSES SAVED AND ITS MONETARY BENEFIT PER HOUSEHOLD

S.No	Pulses stored	Quantity stored	Quantity saved	Money value* (`)
1	Black gram	25 kg	(10%) 2.5kgs	275
2	Green gram	20 kg	(10%) 2 kgs	200
3	Cowpea	8 kg	(8 %) 650 g	40
5	Black channa	5 kg	(9-10%) 500 g	32
6	Peas	5 kg	(9-10%) 500 g	25

*Black gram- `.110, Green gram - `.100, Cowpea - `.62, Black channa -`.65, Peas - `.50

Monetary benefits for farmers who store large produces may not be quantified precisely; however safe storage practices discussed in the study could help farmers gain pricing power during off season period. With the lack of knowledge on the safe storage practices, they sell in the peak season at lower price due to time bound pressure to sell the produce before it starts to deteriorate and to avoid cost incurred in using chemical insecticides which are expensive and hazardous. By following the safe storage practices using botanicals farmers could store longer and gradually become price makers in the off season period from being a price followers in the peak production season. Plate 18 shows the adoption practices of using botanicals during storage of pulses by the selected homemakers and shop keepers.

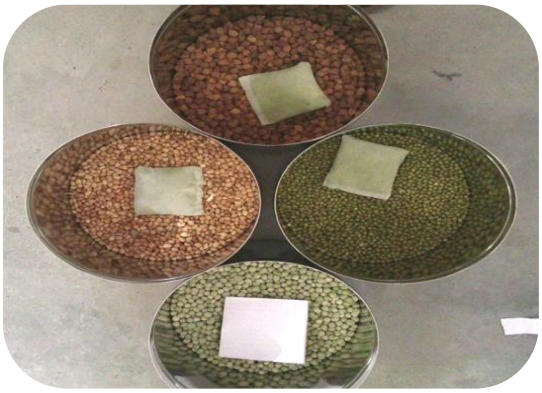





Plate 18

Adoption Practices of Using Botanicals during Storage of Pulses by Homemakers and Shop keepers

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Hypothesis

Adopting the method of using different botanicals during pulses storage may not solve storage problems

It could be concluded from the above results (Table XXVII, XXX, XXXI, and XXXII), that adoption of using different botanicals during pulses storage definitely solved storage problems. **Hence the above hypothesis is rejected**. The homemakers and shop keepers improved their storage by adopting safe storage techniques and with the use of selected botanical leaf powders.

11. Opinion regarding the safe storage techniques and adoption of botanical leaf powders during storage of pulses by homemakers and shop keepers

The results emphasized that adoption of safe storage techniques, and use of botanical leaf powders to prevent insect and pest in stored pulses unquestionably reduced the storage losses. The opinion regarding the adoption of botanical leaf powders during storage to prevent insect and pest in stored pulses was assessed and presented in Table XXXIII.

TABLE XXXIII

OPINION REGARDING THE USE OF BOTANICAL LEAF POWDERS DURING STORAGE OF PULSES

S. No	Opinion of the homemakers and shop keepers	Responses in Percentage	
		Homemakers (N=300)	Shop keepers (N=16)
1.	Botanicals are available at free of cost	100	100
2.	More effective in preventing insect and pest attack	100	100
3.	No usage of chemicals and pesticide for storage	99	96
4.	Removal of these botanical powders from pulses before consumption is not essential as it has medicinal properties	98	95
5.	Possible to store pulses for longer period without using chemicals	97	95
6.	Selected botanicals are non toxic to humans	97	93
7.	Easily available	95	92
8.	Rapid handling	92	90
9.	Safe to use	90	90
10.	Easy to adopt	89	85

Cent per cent of homemakers and shop keepers opined that botanicals are available at free of cost and it is more effective in preventing insect and pest attack. Ninety nine and 96 per cent of homemakers and shop keepers respectively expressed that use of chemicals and pesticide for storage of pulses is not needed any more. Ninety eight and 95 per cent of homemakers and shop keepers respectively felt that conscious removal of these botanicals leaf powders from pulses before consumption is not essential as it has medicinal properties. Other opinions expressed by them were possibility to store pulses for longer period without using chemicals. Besides they also realized that botanicals are non toxic to humans, easily available, possibility for rapid handling, safety in use, easy adoption and higher level satisfaction obtained.

12. Suggestions for better adoption on using botanicals in storage by selected homemakers and shop keepers

The suggestion put forth by the homemakers and shop keepers for better adoption of safe storage practices and the use of botanicals in pulses storage is presented in Table XXXIV.

TABLE XXXIV

SUGGESTIONS FOR BETTER ADOPTION ON THE USE OF BOTANICALS IN STORAGE BY HOMEMAKERS AND SHOP KEEPERS

S.No	Suggestion for better adoption	Responses in Percentage	
		Homemakers (N=300)	Shop keepers (N=16)
1	Availability of botanical leaf packets in the market	85	90
2	Increase the cost for pulses stored with botanicals	-	88
3	Create awareness among large scale storage sectors Improve technical guidance	65	75
4		62	70
5	Educational campaign	50	52
6	Botanical leaf processing centre	48	50

Table XXXIV indicates that 85 and 90 percent of homemakers and shop keepers respectively felt the availability of botanical leaf packets of ideal quantity in the market will be easy for better adoption of the use of botanicals on storage. Eighty eight per cent of

shop keepers felt that the cost of pulses stored with botanicals could be increased considering it on par with the cost of other organic products. The other suggestions put forth were to create awareness among large scale storage sectors, improved technical guidance, conduct of educational campaign on safe storage and setting up botanical leaf processing centre. They also expressed that with the help of these storage techniques, pulses could be stored in a large scale/bulk quantities, which might also help in saving pulses from storage losses and thereby improving the economy of our nation.

The present study proved the effectiveness of *Azadirachta indica* (Neem), *Vitex nigundo* (Nochi) and *Pongamia pinnata* (Pongamia) pulverized leaves to prevent losses of pulses during storage. It is proved that effect different botanicals had a positive impact on the keeping quality of pulses. Safe storage techniques and use of selected botanicals would definitely prevent insects and pest damage and maintain quality of pulses during storage. The training programme helped the homemakers and shop keepers to improve their storage practices, leading to optimum saving of pulses and improved health status of people.

Swami Vivekananda said:

'An Ounce of practice is better than tonnes of talk'.

Let us pledge to practice.