# NUTRITIONAL EVALUATION AND PROCESSING OF PEA (*PISUM SATIVUM VAR. SATIVUM*) VARIETIES

**By**

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*Thesis submitted to CCS Haryana Agricultural University in partial fulfillment of the requirements for the degree of*

## MASTER OF SCIENCE

## IN

## FOOD AND NUTRITION

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*Dedicated*

*To*

*My Bhai*

*Who is always with me*

# CERTIFICATE – I

This is to certify that this thesis entitled **'Nutritional Evaluation and Processing of Pea (*Pisum Sativum Var. Sativum*) Varieties',** submitted for the degree of **Master of Science,** in the subject of **FOODS AND NUTRITION** to the CCS Haryana Agricultural University, is bonafide work carried out by **SONIA TANDON** under my supervision and that no part of this thesis has been submitted for any other degree.

The assistance and help received during the course of investigation have been fully acknowledged.

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# CERTIFICATE – II

This is to certify that this thesis entitled **'NUTRITIONAL EVALUATION AND PROCESSING OF PEA (*PISUM SATIVUM VAR. SATIVUM*) VARIETIES',** submitted by **SONIA TANDON** to the Department of Foods and Nutrition, I.C. College of Home Science, CCS Haryana Agricultural University, in partial fulfillment of the requirements for the degree of **Master of Science,** in the subject of **FOOD AND NUTRITION** has been approved by the Student's Advisory Committee after an oral examination on the same.

**MAJOR ADVISOR** **HEAD OF THE DEPARTMENT**

**DEAN, POSTGRADUATE STUDIES**

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**Date :** **(SONIA TANDON)**

**Place : Hisar**

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**CHAPTER-I**

# *Introduction*

Garden pea (*Pisum sativum)* is a leguminous vegetable crop of immense importance from nutritional and economic considerations. Peas are cultivated widely in all tropical and subtropical countries of the world as winter (*rabi*) crop. Currently, it ranks among the top ten vegetable crops, and is one of the most popular vegetables for home use by home gardeners. It is consumed in several ways or forms i.e. fresh green peas, dehydrated peas, frozen peas and processed canned peas.

The word ópeaô has been derived from the Greek word pison, which became Pease in Middle English and later shortened to pea (Savage and Deo, 1989). The role of seed legumes in diets of animals and man in developing countries is well documented (Oke *et al.* 1995; Agbede, 2000). Leguminous seed have been reported to be excellent sources of protein and energy (Oke *et al.* 1995) in animals and human diets.

India is the 5$^{th}$ largest producer of peas in the world. The major producing states are Uttar Pradesh, Punjab, Himachal Pradesh, Orissa, Karnataka and Haryana. According to FAO (2001), the estimated area under pea cultivation is 459 thousand hectares with a yield of 3535

thousand metric tones. Maximum cultivation of pea is in Uttar Pradesh, which accounts for about 60 per cent of area under this crop followed by Bihar and Madhya Pradesh. The position of pea crop in Haryana is not so satisfactory because it covers little area and production of this vegetable crop is quite low (10q/ha).

Fresh peas have high calorific value (93 Kcal/100g) and rich sources of proteins, sugars and other carbohydrates (Das *et al.* 1993). With the advancement in maturity, the calorific value of peas increases substantially due to notable changes in carbohydrate make up of the grains (Das *et al.* 1992). Green peas also contain appreciable amounts of vitamins and minerals. Pea grains also contain reasonable quantity of dietary fibre (Das *et al.* 1993). Remarkable differences in physico-chemical characteristics of different varieties of peas are found (Das *et al.* 1993)

Protein content of green peas varies between 15 and 28.8 g 100g grains. Only 60.4-66.5 percent of protein was found to be digestible (in vitro) by Saharan (1991) and Bishnoi (1991). *In vitro* starch digestibility of garden peas ranges between 30.5 and 36.52 percent Bishnoi (1991). As with other leguminous crops, garden peas also contain high amounts of antinutrients like phytic acid and polyphenols. Phytic acid content ranges between 162.5 and 892 mg per 100g (Manan *et al.* 1987; Savage, 1989; Bishnoi, 1991; Das *et al.* 1993; Zdunczyk *et al.* 1997) whereas polyphenol content of green peas have been reported to vary from 0.77-2.6mg/g (Savage and Deo, 1989; Bishnoi, 1991; Wilskajeszka and Stasiak, 1994; Zdunczyk *et al.* 1997) Savage (1989) had earlier reported 0.20ï 1.30 mg/g tannin and 0.10-0.03 mg/g tannin and 0.01-0.03 mg/g

phenolic compounds in peas. However, compared with some other legume species, pea seeds contain relatively less antinutritional substances mainly phytates and tannins, lectins, trypsin inhibitors and galactosides (Huisman and Jansman, 1991). Since the per capita availability of legumes is low the consumption of pea need to be encouraged.

Fresh peas contain 70-80 per cent moisture and are highly perishable and the duration of availability is short, extending from 2-3 months. Bulk of crop is received in market during a short period of one month causing seasonal glut and uneconomic returns to growers. Moreover, green peas have a short life. So, development of pea varieties is a continuous process to facilitate their availability during the off-season and in minimizing the seasonal glut. But, not all varieties developed are suitable for processing like dehydration, canning, freezing etc. In developed countries almost 99 per cent of total production of fresh garden peas is processed in one or other form and rest of production is marketed fresh. However, in developing countries like India, only 1-2 per cent of total green pea production is processed as dehydrated and frozen ones and rest of the marketed fresh. Proper storage of fresh vegetables during the peak season can prevent the crash in prices to a large extent and can also extend the shelf life of vegetables in order to stretch their supply to a large section of population.

A large value of pea varieties have been breed through out country, however our knowledge in different aspects of dehydration of fresh pea is meager as compared to that of other vegetable. Very few cultivars have been commercially exploited for their utilization of dehydrated and

frozen products (Jain and Chaudhary, 1963; Kuppuswamy and Rao, 1970; Khurdiya *et al.* 1972; Beerh and Kurien, 1976; Rodriguez *et al.* 1979 and Das *et al.* 1993).

Shah *et al* (1975) reported that the desirable characteristics of a pea variety for processing were uniform maturation, predictable maturity and growing habits, which facilitate mechanical harvesting. They also reported that almost all varieties developed and commonly used for canning and freezing processes are also suitable for dehydration.

Preservation of vegetables involves drying, refrigeration, canning and freezing. By drying and freezing shelf life can be enhanced. By refrigeration, the shelf life can be increased to 2-3 weeks only (Srivastava and Kumar, 1998) and by modified atmosphere packaging in polythene pentene films shelf life can be extended to about five weeks at $5^0$C (Pariasca *et al.* 2001). The nutrient status of frozen peas is similar to that of the typical market purchased vegetable and is superior to peas that have been stored in home for several days (Favell, 1997). The canned processed peas can be made available through out the year but they are expensive and out of reach of common men.

Sun drying, oven drying and fluidized bed drying etc. are methods of drying. But mechanical drying should be followed as it may help in the retention of required quality of peas (Kanawade and Narian, 1993). Drying of peas results in considerable reduction in weight, produces shelf stable products, reduces storage space and packaging requirements and facilitates transportation easily to far off places (Kuppuswarny and Rao, 1970). Processed peas are now-a-days gaining popularity because they offer the advantages of shelf life, palatability, and convenience during

transport and handling. To achieve a dehydrated product of high quality the drying process should allow effective retention of colour, flavour, texture, taste and nutritive values.

During the year 1999, India exported 281.85 mt. of dried peas alone valued at 3547 million Rs. (Singhal, 1999). Frozen peas are also in very much in demand. Non-availability of processing varieties of raw materials in adequate quantity is one of constraints of growth of food industry of India (Kapoor, 1998).

Securing of available varieties of peas suitable for drying and freezing and study of various aspects of dehydration such as blanching time and temperature, drying time and temperature, freezing time and temperature etc. become very important to achieve a dehydrated and frozen product of good quality. Many promising genotypes of pea developed by HAU are in final stages of their release for general cultivation. All cultivars are not suitable for processing. So, it was considered imperative to study nine varieties with following objectives :

1. To assess the nutritional composition of pea varieties.
2. To carry out freezing and dehydration of selected pea varieties.
3. To compare the acceptability and nutritional composition of dehydrated and frozen pea.

**CHAPTER-II**

# *Review of Literature*

Peas (*Pisum sativum* L.) is a leading vegetable crop grown all over India. It is leguminous vegetable of immense importance from the nutritional and economic point of view. Nutritionally, green peas are good source of proteins, vitamins, minerals, sugars and other carbohydrates. It plays a paramount role in our daily diet, as majority of Indian population is vegetarian. The present investigation was undertaken with an objective to study the nutritional qualities of pea varieties and processing of pea varieties. The literature concerning the nutrient composition and processing of peas has been reviewed under following heads:

2.1 Physical properties
2.2 Nutritional composition
2.2.1 Proximate composition
2.2.2 Carbohydrates
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## 2.1 Physical Properties

Physico-chemical characteristics of different cultivars of peas grown in India have been studied by many workers (Bhatia *et al.* 1963; Kalra *et al.* 1986; Das *et al.* 1992; Das *et al.* 1993; Pawar *et al.* 1994; Zdunczyk *et al.* 1997). Results of various workers is given in Table 2.1.

**Table 2.1 Physical Properties of pea**

| Character | Range | References |
|---|---|---|
| 1) Pod length (mm) | 79.40 ï 94.70 | Zyl (1966); Chowdhary and Singh (1970); Singh *et al.* (1974); Rodriguez *et al.* (1979); Korla and Singh (1988); Das *et al.* (1992); Pratap *et al.* (1992); Shah and Lal (1992); Pawar *et al.* (1994); Gupta *et al.* (1998); Pan and Prasad (2000); Kumarn *et al.* (1995); Sheriful (2002); Singh and Singh (2006). |
| 2) Pod width (mm) | 9.96 ï 17-80 | Rodriguez *et al.* (1979); Das *et al.* (1992); Pawar *et al.* (1994); Singh (1995); Pan and Prasad (2000); Sheriful (2002). |
| 3)Pod thickness (mm) | 10.01 ï 16.10 | Das, *et al.* (1992); Pawar *et al.* (1994); Sheriful (2002). |
| 4) pod weight (g) | 2.25 ï 4.98 | Nandpuri *et al.* (1973); Singh *et al.* (1973); Korla and Singh (1988); Pawar *et al.* (1994); Sheriful (2002). |
| 5) Pea grain weight (g) | 1.23 ï 2.44 | Gupta *et al.* (1986); Pawar *et al.* (1994); Vikas and Singh (1999). |
| 6) Shell weight (g) | 1.02 ï 2.28 | Das *et al.* (1992); Pawar *et al.* (1994); Kumaran *et al.* (1995). |
| 7) Shelling percentage (%) | 30.70 ï 56.40 | Vishnu Swarup (1978); Korla and Singh (1988); Das *et al.* (1992); Khurdiya *et al.* (1992); Pan and Prasad (2000). |
| 8) Pea grain to shell ratio | 1.01 ï 1.20 | Pratap *et al.* (1992); Pawar *et al.* (1994); Kumaran *et al.* (1995). |

## 2.2 Nutritional Composition

### 2.2.1 Proximate Composition

Pea is a highly nutritious vegetable and a rich source of protein, carbohydrate, vitamin A and C, calcium, phosphorous and contain reasonable quantity of dietary fibres. Reports related to Nutritional composition of peas have been presented under this head.

Agarwal *et al.* (1969) reported a range of 71.87 to 75.40 per cent moisture in pea varieties. Khurdiya *et al.* (1972) observed 76.3 to 79.2 per cent and Kaur *et al.* (1976) 75.08 to 77.48 per cent moisture content, respectively in different varieties of peas. Michael Eskin (1984) quoted value of moisture content ranging from 71.25 to 76.01 per cent in different varieties of peas. The cylindrical pods of four cultivars, namely Early Badger, Bonneville, Khaparkheda and P-388-1 were found to contain moisture content ranging from 71-25 to 73.65 per cent (Pawar *et al.* (1994). Sheriful (2002) analyzed four varieties of pea i.e. Pb-87, Matar Ageta -6, P-1 and P-2 and reported that moisture content varied from 77.10 to 78.30 per cent. Moisture content was found to be 76.39 per cent in fresh green pea (Ruchika, 2004).

The pea contains high level of protein and digestible carbohydrates and low concentration of fibre and fat (Savage and Deo, 1989). According to Pandey and Gritton (1975) crude content varied considerately between 9 cultivars of peas. The crude protein content of mature peas reported by them are exceptionally high, for instance, cultivar Tiny had a crude protein content of 38.3 per cent in first experiment and 32.60 per cent in the second. Renu and Bhattacharya

(1989) studied the proximate composition of improved genotype of peas and reported that crude protein content of peas varied from 15.0 to 29.3 per cent. Das *et al.* (1992) noticed that protein was maximum in Hb-B and seemed to increase with maturity. Protein of pods ranged between 7.0 to 11.04 (maturity-I) and 14.6 to 18.6 (maturity-II) percent. Similarly, Black (1998) found that protein level of pea (dry matter basis) ranged from 19.4 to 31.0 per cent. Protein content of green peas varied between 15.6 and 32.5 g per 100g gains (Evans and Boulter, 1980; Deo, 1987; Johns, 1987; Gueguen and Barbot, 1988; Savage and Deo, 1989; Saharan, 1991; Gdala *et al.* 1992; Das *et al.* 1993; Gatel, 1994; Shukla and Kohli, 1992; Zdunczyk *et al.* 1997) Kosson *et al*. 1994a documented that the protein content of whole wrinkled peas ranged between 24.69 to 26.32 percent for different pea cultivars. In a study given by Sheriful (2002) the protein content was found to vary from 22.63 to 25.41 per cent in four pea varieties i.e.Pb-87, Matar Ageta-6, P-1 and P-2. The wide range of crude protein is the reflection of variation among pea cultivars, which is affected by both genetic and environmental factors (Savage and Deo, 1989).

Like many another legume seeds, the fat content (ether extract) in pea is low ranging from 0.8 to 6.1 per cent (Savage and Deo, 1989). Bishnoi, 1991analysed four pea varieties i.e. Bonneville, Arkel, HFP-4 and Rachna and indicated that fat content varied from 1.47 to 2.79 per cent. Fat content was found to be maximum in Pb-88 (4.49) and lowest fat content was observed in Pb-87 (Das *et al.*, 1992). According to Savage and Deo (1989) the ash content of raw seeds ranged from 2.4 to 4.1 per cent. Bishnoi (1991) reported that ash content in different field

and vegetable pea varieties ranged from 2.83 to 4.08 per cent. Das *et al.* (1993) studied the nutritional composition of various pea varieties (Pb-87, Pb-88 and Hb-B) and concluded that ash content varied from 3.43 to 4.15 per cent. Pawar *et al.* (1994) given the value of ash content i.e. 2.95 to 3.44 per cent in pods of four cultivars, namely Early Badger, Bonneville, Khaparkheda and P-388-I. Similarly, in an earlier study of Sheriful (2002) the ash content ranged from 3.27 to 4.00 per cent among the various pea varieties i.e. Pb-87, Matar Ageta-6, P-1 and P-2.

The crude fibre content of pea seeds is also low and ranges from 1.1 to 9.9 per cent (Savage and Deo, 1989). Fibre content varied from 3.97 to 10.30 per cent in pea varieties i.e. Bonneville, Arkel HFP-4 and Rachna was reported by Bishnoi (1991). Das *et al.* (1993) observed a wide variation in crude fibre content of Pb-87, Pb-88 and Hb-B pea varieties, which ranged from 1.87 to 4.49 per cent. Sheriful (2002) studied the chemical composition of fresh peas of different cultivars of M1 maturity and indicated that crude fibre content was highest in Pb-87 (8.29%) and lowest in Matar Ageta-6 (7.09%).

Alcohol insoluble solid contain cellulose, hemicellulose, proteins, starch, pentosans etc. Bhatia *et al.* (1963) studied that AIS content increase with maturity. Kalra *et al.* (1986) studied variation in four varieties of pea and the AIS content varied from 15.12 to 18.29 per cent. Ruchika (2004) reported the value of alcohol insoluble solid to be 15.56 per cent in fresh peas. Sheriful (2002) analyzed the chemical composition of fresh peas of different cultivars of M1 maturity and stated that the AIS content varied from 11.45 to 13.05 per cent.

### 2.2.2 Carbohydrates

Carbohydrates are generally divided into starches, sugars and non-starch polysaccharides. Starch is often the major component of many grain legumes (Saini and Kughts, 1984). The chemical composition of native starch is reported to contain moisture 9.1, nitrogen 0.26, fat 0.10, ash 1.10, phosphorous 0.012 and amylase 33.2 per cent. Kooistra (1962) found that smooth peas contained considerable higher starch contents (440 to 463 g/kg) than wrinkled peas (280 to 337 g/kg). Agarwal *et al.* (1969) reported that starch content in pea varieties varied from 4.63 to 7.60 per cent. Richter (1976) stated that smooth variety of peas contained more starch (46.04 $\pm$ 1.85% db) as compared to wrinkled peas 33.75 $\pm$ 0.76% db). In a study given by Bishnoi (1991) the starch content ranged from 53.42 to 63.75 g/100. Starch content in various pea varieties varied from 20.70 to 30.00 per cent in different pea cultivars (Das *et al.* 1993; and Periago *et al.* 1996). Starch content in pea was found to be 7.34 per cent day Panwar (1999). Sheriful (2002) studied the starch content of fresh peas of different cultivars of M1 maturity and observed that Pb-87 Contained higher (23.36%) starch content whereas lowest starch content (20.54%) was noticed in Matar Ageta -6. The value (4.85%) of starch has been given by Ruchika (2004) in her earlier study.

Cerning-Beroard and Filiatre (1976) observed that wrinkled peas contained more ethanol soluble sugars. Several other workers also determined the sugar content of different varieties of peas (Abbas and Ram, 1972 and Kaur *et al.* (1976). Bishnoi (1991) and Das *et al.* (1993) studied various pea varieties for their total soluble sugars and reported that total soluble sugars ranged from 5.81 to 21.90 per cent. Total soluble

sugar was found to be 7.34 per cent in green peas in a study given by Panwar (1999). The sugar content of different cultivars of pea varied from 3.61 per cent to 4.17 per cent as reported by Sheriful (2002). Ruchika (2004) analyzed pea for total soluble sugar content and reported the value to be 7.43 per cent.

Agarwal *et al.* (1969) reported that no appreciable amount of reducing sugars were present in the winter varieties of peas. Bishnoi (1991) analyzed four pea varieties i.e. Bonneville, Arkel, HFP-4 and Rachna for their reducing sugar content and found that reducing sugar varied from 0.41 to 0.57 per cent. Panwar (1999) given the value (0.79%) for reducing sugar in green pea. In a study given by Ruchika (2004) reducing sugar content in fresh green peas was observed to be 7.43 per cent.

In a study conducted on four varieties i.e. Bonneville, Arkel, Aparna and Rachna the non-reducing content was found to range between 5.38 to 6.44 percent (Bishnoi, 1991). Almost similar value (6.55%) for non-reducing sugar has been reported by Panwar (1999) in fresh green peas.

### 2.2.3 *In vitro* digestibility

Bennink and Srisuma (1989) reported that the digestibility of starch and protein in legumes is lower than that in cereal grains because of higher dietary fibre. Only 60.4 ï 66.5 per cent of protein and 30.50-36.53 percent of starch was found to be digestible (*in vitro*) in various pea varieties as given by Saharan (1991) and Bishnoi (1991). Grete *et al.* (1994) studied the three pea varieties i.e. Dinos, Tristar and Uniroy and

reported that mean value of *in vitro* protein digestibility was 92.1%. Panwar (1999) studied green peas and found that *in vitro* protein digestibility and *in vitro* starch digestibility was 66.51 per cent and 31.77 mg maltose released/g meal respectively.

### 2.2.4 Total Minerals

Bishnoi (1991) analyzed four pea varieties i.e. Bonneville, Arkel, HFP-4 and Rachna for chemical composition and found that calcium and iron content varied from 25.6 to 35.1 and 10.45 to 12.51 mg respectively in various varieties. Wide range in calcium content i.e. 25.6ï 140 mg of fresh garden peas has been given by Bishnoi and Khetarpaul (1995). Iron content ranged from 2.2 to 49.0 mg as reported by various workers (Kumar and Kapoor, 1983; Wills *et al.* 1984; Lopez *et al.* 1986; Bishnoi and Khetarpaul, 1995). Lower iron content (9.06 mg) was observed in fresh garden peas by Panwar (1999). He also reported that calcium content was found to be 125.00 mg in fresh garden peas.

Zinc content in various pea cultivars i.e. Bonneville, Arkel, HPF-4 and Rachna was found to vary form 3.15 to 5.41 mg (Bishnoi, 1991).

### 2.2.5 Antinutrients

As like other leguminous crops, garden peas also contain high amount of antinutrients like phytic acid and polyphenols. Phytic acid is also considered to be an antinutritional factor in peas (Savage and Deo, 1989). Phytic acid content ranges between 162.5 and 892 mg per 100g (Manan *et al.* 1987; Savage, 1989, Bishnoi, 1991; Das *et al.* 1993; Zdunczyk *et al.* 1997). However, compared with some other legumes species, pea seeds contain relatively less antinutritional substances mainly

phytates and tannins, lectins, trypsin inhibitors and α-galactosides (Huisman and Jansman, 1991). Panwar (1999) reported value of phytic acid content and polyphenol content to be 1350.29 and 865.67-mg/100g respictively in garden peas.

Polphenols, also called tannins are mainly present in the seed coat of legume and interfere with the biological value of grains. Polyphenol content of green peas have been reported to vary from 0.77 ï 2.6 mg/g (Savage, and Deo, 1989; Bishnoi, 1991; Wilskajerzka and Stasiak, 1994; Zdunczyk *et al.* 1997). Panwar (1999) reported value of phytic acid content and polyphenol content to be 1350.29 and 865.67-mg/100g respectively in garden peas.

**2.2.7 Vitamins**

Green peas also contain appreciable amounts of vitamins. ß-carotene plays a role in reducing the risk of cancer, heart disease, maintaining good eyesight, boosting immune system and slowing ageing. Studies have shown that high intake of ß-carotene is associated with reduced risk of heart attack and stroke (Renger *et al.* 1991). ß-carotene, vitamin A precursor, has been identified as a potential anticarcinogen as well as an antioxidant (Sies and Stahl, 1995). The ß-carotene was found to range from 76.70 to 78.23 µg/100g in various pea varieties (Sheriful, 2002 and Ruchika, 2004).

Vitamin C (ascorbic acid) is a highly versatile, water-soluble antioxidant. Based on survey of 17.76 per cent varieties of peas, Mack and Tressler (1936) reported a range from 19 to 41 mg/10g. Ascorbic acid content varied from 25.10 to 29.10 mg/100g as reported by Kaur *et al.*

(1976) and Das (1979). Ascorbic acid content ranged from 38.8 to 157.2 mg, db as reported by various workers (Michael and Eskin, 1984; Das *et al.* 1993; Pawar *et al.* 1994). Das *et al.* (1993) given the value of ascorbic acid (10.80 ï 29.61%), FW) in various pea cultivars. In a study Favell (1997) revealed ascorbic acid content to range from 25.60 to 30.90 mg/100g in various pea varieties. Sheriful (2002) studied ascorbic acid content of fresh peas of different cultivars and found that ascorbic acid content ranged from 24.59 to 29.90 mg/100g.

### 2.2.7 Pigments

#### 2.2.7.1 Total Chlorophyll

Factors such as variety, maturity, vigor of the crop and sunlight influence the chlorophyll content of peas (Shah *et al.* 1976). Khurdiya *et al.* (1972) reported a value for chlorophyll as 18.4 mg/100g for the little Marvel variety of peas. Chlorophyll content varied from 9.28 to 11.60 mg/100g in various pea cultivars (Kalra *et al.* 1986; Das *et al.* 1992). Das *et al.* (1993) studied the various pea cultivars and found that chlorophyll content varied from 9.20 to 11.01 mg/100g. Sheriful (2002) reported that chlorophyll content varied from 9.30 ï 11.90 mg/100g in fresh peas of various cultivars of M1 maturity i.e. Pb-87, Matar Ageta-6, P-1 and P-2. Ruchika, 2004 analyzed green peas for its nutritional composition and reported that chlorophyll content was 9.30mg/100g.

### 2.2.8 Cooking quality

Cooking quality parameters such as hydration capacity, swelling capacity and cooking time are important parameters, which ultimately play an important role in its behaviour for cooking and processing.

Hydration capacity and swelling capacity varied from 0.18 to 0.24 g/seed and 0.43 to 0.55 ml/seed respectively among the different vegetable and field pea varieties i.e. Bonneville, Arkel, HFP-4 and Rachna. (Bishnoi, 1991). Cooking time is of paramount importance, as most of the legumes require long period of cooking. Cooking time has several definitions, such as the time at which 50 per cent of seeds become soft (cooked) or 100 per cent softening. Actual cooking time should be the time between the beginning of test and when seeds are ready for eating. Bishnoi (1991) also in her study noticed that cooking time varied from 83 to 106 minutes in various pea varieties.

## 2.3 Processing of pea

### 2.3.1 Dehydration

Drying is the process of removing water from the food stuffs to such an extent so that none of the microorganism may penetrate to cause spoilage .The prime objective of drying is preservation by reducing the water activity hence producing the shelf life of food stuffs. The other objective is to reduce bulk so that it may be economical to handle, transport and distribute (Dayanand, 1978).

Bhatia *et al.* (1963) studied that AIS content increases with maturity. AIS value of 9-19 per cent has been considered as the optimum range for the high quality of the dehydrated product. Khurdiya *et al.* (1972) studied the extent of chlorophyll losses on dehydration of little Marvel variety of peas with an initial chlorophyll content of 85.1 mg/100g. The value decreased to 48.3 mg/100g after dehydration. Sehgal, *et al.* (1975) analyzed the sun dried green leaves of mustard, brown

mustard and spinach for their chemical components and reported the ascorbic acid and carotene losses between 34.4 and 63.5 and 48.0 and 89.8 percent, respectively. Bongirwar and Sreenivasan (1976) found that peas at <12 per cent moisture were found to be very good after storage up to one year, beyond which moisture absorption by the peas to a certain extent did occur resulting in increase of cooking time.

Kulesza and Gertig (1976) recorded protein content in the dehydrated peas and noticed decrease in protein content during storage. Goyal and Mathew (1980) observed significant loss in ascorbic acid in cauliflower leaves on drying which may be due to thermal leaching or oxidative changes.

Ranganath and Dubash (1981) studied the changes in content of ascorbic acid on dehydration of vegetables and reported a loss of 50 percent and 36-39 percent in ascorbic acid content of spinach leaves and sweet potato, respectively when stored at about $24^0$C.Maede and Salunkhe (1981) reported that 17.4 and 12.4 percent total carotene was retained when drying was done in enclosed dried with shade and without shade, respectively.

Tondon *et al.* (1981) investigated dehydration of green peas in solar dryer. It was reported that during the drying process chlorophyll contents were reduced to more than half and a direct relationship between chlorophyll loss and residual moisture content was observed. During drying of tomatoes, 38.8 percent ascorbic acid was lost and loss was higher in blanched and sun dried soup (Gupta and Nath, 1984). Okoh (1984) observed significant loss of ascorbic acid in air dried vegetables as

compared to raw vegetables. Pawar *et al.* (1985) reported that drying and dehydration of untreated pumpkin slices caused a loss of about 65.89 and 72.23 percent of ascorbic acid and β-carotene respectively. After three months of storage at room temperature (27-30$^0$C) loss of ascorbic acid and β-carotene was 27-80 and 37.76 percent respectively..

Kalra *et al.* (1986) studied variations in moisture and total sugars in dried fruit of four varieties of pea (*Pisum sativum).* The moisture content and total sugars varied from 75.6ï 77.2 and 3.34 to 4.97 per cent respectively. Mandhyan *et al.* (1988) reported that the total moisture loss was observed to be 60.45 per cent in sun drying and 60.28 per cent of initial moisture of 68.64 per cent in solar cabinet dryer for peas.

Das *et al.* (1992) studied the drying behaviour of three varieties of green peas, Pb-87, Pb-88 and Hb-B and reported that there was notable decrease in dry matter as well as alcohol insoluble solid. Singh *et al.* (1992) dehydrated four varieties of peas (Arkel, Bonneville, Azad and Rachna) by sun drying, after making perforation and mechanical hot air drying. They found maximum retention of dry matter and protein when dehydrated by mechanical means.

Das *et al.* (1993) observed that the protein content of the stored dehydrated peas of different varieties and maturities showed negligible change. He also reported that starch reduced during processing by 9 to 14 per cent. Retention of starch in the Harbona-B variety of pea was quite high and starch content decreased during the storage period. The loss of chlorophyll during storage of dried peas has been reported by various workers (Khurdiya *et al.* 1972; Das *et al.* 1993).

Arora and Bakshi (1994) studied effect of storage on physical characteristics and cooking quality of dehydrated peas and carrot. They reported that moisture content varied from 6.01 to 7.41 per cent in the dehydrated peas during storage. Yadav and Sehgal (1995a) observed 90.49 and 83.40 percent loss of ascorbic acid in sun dried spinach and amaranthus leaves, respectively, whereas less loss was observed in case of oven-dried samples i.e. 90.01 and 82.54 percent, respectively. They reported greater loss of β-carotene in sun drying of vegetable as compared to oven drying.

Jayaraman *et al.* (1996) reported that among the various drying methods (sun drying, solar cabinet, hot air drying and HTST pneumatic) sun drying resulted in greater loss of chlorophyll than other drying techniques, and also lead to greater levels of browning and lipid oxidation. About 15 percent loss of β-carotene was observed in tomatoes during oven drying (Anita, 1997). Benhura and Chitsika (1997) reported a loss of 92 percent and 93 percent in β-carotene content of sun dried and shade dried guku leaves respectively. He also reported a loss of 38 percent β-carotene after six days of refrigerated storage of leaves. Manimegalai and Ramah (1998) studied the effect of pretreatment on the quality characteristics of dehydrated bitter gourd ring. They reported 20-30 percent loss of ascorbic acid in the stored dehydrated bitter gourd samples. A progressive increase in the loss of ascorbic acid was reported by Kalra *et al.* (1983). The percent loss ranged from 32.7 to 41.4 and from 43.9 to 56.9 during 3 and 6 months of storage respectively

The losses of ascorbic acid content from green leafy vegetables ranged from 69 to 85 percent due to sun drying and 51 to 63 percent due to cabinet drying whereas loss of β-carotene ranged from 24 to 60 percent in sun-dried leaves and 6 to 25 percent in cabinet dried leaves (Lakshmi and Vimala, 2000). Premvalli *et al.* (2001) studied the effect of blanching and dehydration of seven green leafy vegetables. Retention of Vitamin C during blanching and dehydration was found to be from 37.97 percent and 28 to 74 percent respectively. Comparatively vitamin A retained better to the tone of 36-94 percent. Rajkumar and Shreenarayanal (2001) reported a marginal increase in moisture content in all storage method and a significant reduction in ascorbic acid during storage period of three methods. Suman and Kumari (2002) reported 71 percent loss of β-carotene content in carrot dried by direct sunlight, whereas loss was 52 percent in solar cabinet drying followed by 42 percent loss in hot air cabinet dryer. They also reported a gradual loss of β-carotene during storage in all the three dehydrated carrots products.

Sheriful (2002) studied the storage of dehydrated peas of various varieties for six months. He observed that chlorophyll, protein and total sugar content declined throughout the storage period and the decline-varied from 43.3 to 48.65, 0.19 to 0.31 and 0.85 to 1.23 per cent respectively. Starch and ascorbic acid content also declined and varied from 22.13 to 19.38 and 20.54 to 54.73 mg/100g respectively. Whereas moisture content increased during the storage period. Lal *et al.* (2004) reported a loss of about 2.34 percent ascorbic acid and 30.34 percent of protein during the study of oven dried and unsulphited *kachri* slices stored for three months at different temperatures. In a study of storage of

dehydrated peas treated by various blanching treatments starch, alcohol insoluble solid and chlorophyll content declined during storage .The value of starch, alcohol insoluble solid and chlorophyll content ranged from 27.3 to 43.2 per cent, 49.22 to 60.10 per cent and 27.54 to 40.95 mg/100g respectively (Ruchika, 2004).

Kadam *et al.* (2005) studied the influence of different treatments on dehydrated cauliflower quality and reported that ascorbic acid content declined during the storage of six months. The ascorbic acid content varied from 188.46 to 223.86 mg/100g in cauliflower. Santosh (2005) analyzed the dehydrated and frozen baby corn for its chemical components and reported that fat and fibre losses in dehydrated baby corn between 7.5 and 9.39 and 1.87 and 6.45 percent, respectively. She also reported a non-significant decline in *in vitro* starch digestibility and iron content, which varied from 2.33 to 6.35 and 1.30 to 4.92 respectively.

### 2.3.2 Freezing

Freezing is one the best methods of preservation which retains natural, colour, flavour and volatile components. Retention of fresh quality is the main objective of freezing. Freezing provides an environment, which inhibits microbial growth, retards chemical reaction rate and action of food enzymes, which are responsible for spoilage at ordinary temperature.

Desrosier and Tresseler (1977) found that cauliflower retained 80 per cent of its ascorbic acid when it was frozen and 60 per cent after six months of frozen storage. Selman (1978) reported 9.6 ï 27.7 per cent loss of AA in different varieties of peas after blanching for one minute at

$97^0$C in water. Burger (1982) reported that the frozen storage of green beans and peas at ï $8^0$C for 12 months resulted in 52 and 11 per cent loss of AA, respectively.

Bhobe and Pai (1986) reported 14.14, 16, 17, 29.6 and 16.33 percent loss of ascorbic acid in okra, gherkin, capsicum, coriander leaves and fenugreek leaves, respectively during frozen storage of some Indian green vegetables. Halpin and Lee (1987) reported that ascorbic acid content of fresh green peas (blanched at various times/temperatures and stored at ï $23^0$C) decreased gradually during three months of storage period.

Amaro *et al.* (1988) investigated the effects of frozen storage (at ï $18^0$C for 45 and 90 days) on mineral contents (Ca, Cu, Fe, K, Mg, Na, P and Zn) of white asparagus (*Asparagus officinalis*). Statistically significant difference were observed during frozen storage in Cu, Fe, K and Mn concentrations but Zn, Ca, Mg, Na and P levels did not show any significant change (Aparicio *et al.* 1989). During storage at ï $22^0$C, AA was retained for a long duration, the loss being 32.6 per cent after 30 months whereas storage at ï $18^0$C resulted in only 24 per cent loss of AA after 60 days. Hugo *et al.* (1989) observed that reducing sugars and starch levels of frozen green beans were slightly reduced during storage period of 60 days.

Michalik and Hallas (1991) studied the freezing quality of different varieties of carrots and found that there was no difference in the content of sugars in fresh, blanched and frozen samples of various varieties. Polo *et al.* (1991) studied the effect of freezing on the mineral (Ca, Mg, Cu,

Mn, Ni, and Zn etc.) composition of green beans and peas. Minerals were measured in fresh and frozen stored (-18$^0$C for 7 week) samples. There was no significant loss in the mineral content of vegetables during frozen storage.

Mallet (1993) illustrated that there was little loss of ascorbic acid in peas at the usual storage temperature of ï 18$^0$C and presumably less at lower temperatures but a much more rapid loss at ï 12$^0$C. Pawar *et al.* (1994) studied the varietal differences in physicochemical characteristics and quality of frozen peas. The reported that there was decline in moisture content of frozen peas during storage of 4½ months and moisture content ranged from 71.01 to 74.10 per cent in various pea cultivars. He also reported a slight decrease in ash content in all the pea cultivars and a remarkable decline in ascorbic acid content during 4½ months of frozen storage period.

Selman (1994) observed vitamins in frozen vegetables. During frozen storage, AA was fairly stable over a period of one year at temperature below ï 20$^0$C to ï 25$^0$C and a loss of 10 per cent was expected. Howard *et al.* (1996) reported that ascorbic acid level decreased linearly by about 10 per cent per week during storage of carrot, broccoli and corn at ï 4$^0$C for 3-12 weeks. Lisiewska and Kmiecik (1996) studied the effects of processing conditions and period of storage on AA retention in frozen broccoli and cauliflower. Freezing resulted in little change of the AA content, which was 15-18 per cent in broccoli, and 6-13 per cent in cauliflower during frozen storage.

Oruna-Concha *et al.* (1996) reported that the sugar content was unaffected by frozen storage at ï22$^0$C upto 12 months. Similar results have been reported by Lisiewska and Kmiecik (2000). Favell, D.J. (1997) compared vitamin C content of fresh and frozen vegetables and concluded that there was a rapid loss of ascorbic acid from all the vegetables except carrot, at ambient temperature and this rapid loss was also seen at chill temperatures for spinach and whole green beans. The rate of loss of ascorbic acid from peas, carrots and broccoli was slow at chill temperature.

In a study of frozen storage of hamburg and parsley, hamburg and parsley leaves lost 64 percent and 42 percent vitamin C and 27 percent and 47 percent of β-carotene respectively upto three months of storage (Lisiewska and Kmiecik, 1997). Yadav and Sehgal (1997) reported that the percent loss of ascorbic acid ranged from 2.03 to 8.77 percent and 45.15 to 66.90 percent in leaves stored in the refrigerator and at 30$^0$C respectively. Similarly, losses were lower i.e. 0.00 to 1.75 percent and 1.63 to 2.84 percent in β-carotene content of leaves stored in refrigerator of at 30$^0$C respectively.

Statistically significant reduction was detected in the concentration of carotenoids, ß-carotene and lycopenes during storage of frozen tomato. Whereas frozen storage of 12 months at ï20$^0$C had no effect on total nitrogen, dietary fibre and ash content of frozen tomato cubes (Lisiewska and Kmiecik, 2000). Athan and Taylor (2000) reported that vitamin C content of Wattieôs freshlock™ peas drop to 16.6 mg/100g from 19.2 mg/100g during 3 months of frozen storage. At twelve months vitamin C

content of Wattieôs freshlock™ peas was 15.78 mg/100g showing a total loss of only 18 per cent from harvesting to twelve months of storage (Athan and Taylor, 2000). Jaswinder (2003) reported slight but non-significant decrease in protein content of frozen stored vegetables i.e. beans, okra and capsicum. Santosh (2005) analyzed the frozen baby corn and reported a loss of about 7.51 to 9.39 percent fat, 1.87 to 6.45 percent fibre, 4.38 to 8.77 per cent iron and 2.53 to 7.22 percent in vitro protein digestibility during the study of frozen baby corn for three months.

**CHAPTER-III**

# *Materials and Methods*

The present investigation entitled, ñNutritional evaluation and processing of pea (*Pisum sativum varieties sativum*) varietiesò was carried out in the Department of Foods & Nutrition, COHS, CCS Haryana Agricultural University, Hisar.

This chapter contains relevant information pertaining to research design and methodological steps used for the present investigation. The research procedures to achieve the planned work have been distinctly described under the following heads:

3.1 Procurement of material

3.2 Physical properties

3.3 Proximate composition

3.4 Carbohydrate

- 3.4.1 Starch
- 3.4.2 Total soluble sugars
- 3.4.3 Reducing sugars
- 3.4.4 Non-reducing sugars

3.5 *In vitro* digestibility

- 3.5.1 *In vitro* protein digestibility
- 3.5.2 *In vitro* starch digestibility

3.6 Total minerals (Ca, Fe and Zn)

3.7 Anti nutrients

3.7.1 Phytic acid

3.7.2 Polyphenols

3.8 Vitamins

3.8.1 ɓ-carotene

3.8.2 Ascorbic acid

3.9 Pigments

3.9.1 Total chlorophyll

3.10 Development of curry and dry vegetable

3.11 Organoleptic evaluation

3.12 Processing of pea

3.12.1 Dehydration of pea

3.12.1.1 Sundrying

3.12.1.2 Oven drying

3.12.2 Freezing of pea

3.13 Cooking quality

3.14 Nutritional evaluation

3.15 Organoleptic evaluation

3.16 Statistical analysis

## 3.1 PROCUREMENT OF MATERIAL

Nine varieties of pea i.e. Arkel, VL-3, NDVP-08, Azad, HVP-03-04, HVP-03-06, HVP-01-29, HVP-03-08 and HVP-03-14 were procured from the experimental farms of Department of Vegetable Science, CCS Haryana Agricultural University, Hisar. All these are vegetable peas varieties.

Peas were depodded and grains were dried in the oven at 50**C** till moisture free. The dried samples were powdered in an electric grinder (Cyclotec M/s Tecator, Hoiganas, Sweden using 0.5mm sieve size), packed in airtight containers for further chemical analysis.

## 3.2 PHYSICAL PROPERTIES

### 3.2.1 Pod length

Measurement of pod length (mm) was taken on 25 randomly selected pods to get the average length of pods.

### 3.2.2 Pod width

Measurement of pod width (mm) was taken on 25 randomly selected pods to get the average width of pods.

### 3.2.3 Pod thickness

Measurement of Pod thickness (mm) was taken on 25 randomly selected pods to get the average thickness of pods.

### 3.2.4 Pod weight

Randomly selected 25 pods were weighed to get the average weight of pods.

### 3.2.5 Pea grain weight

Grains obtained from 25 randomly selected pods were weighed to get the average pea grain weight of pods.

### 3.2.6 Shell weight

Shells of 25 randomly selected pods were weighed to get the average shell weight of pods.

### 3.2.7 Shelling percentage

Shelling percentage (%) was calculated by dividing the pea grain weight with total weight and then multiplying by 100.

### 3.2.8 Pea grain to shell ratio

Pea grain to shell ratio was calculated by dividing pea grain weight with shell weight.

## 3.3 PROXIMATE COMPOSITION

### 3.3.1 Moisture

Moisture content was determined by employing the standard method of analysis (AOAC, 1995).

**Procedure**

Ten gram sample was weighed in a petridish and dried in oven at $105^0$C for six hours or till a constant weight was obtained. The sample was weighed after cooling it in a dessicator.

$$\text{Moisture (\%)} = \frac{\text{Loss in weight (g)}}{\text{Weight of sample (g)}} \times 100$$

### 3.3.2 Fat

Fat was estimated by standard method of analysis (AOAC, 1995) using the soxhlet extraction apparatus.

**Procedure**

Five-gram moisture free sample was transferred to an extraction thimble. The thimble was placed in a soxhlet extractor fitted with a condenser and flask containing sufficient petroleum ether. The extraction was carried out for six hour. After the extraction, thimble was removed

with sample from the extraction apparatus and dried in hot air oven to a constant weight. It was cooled in a dessicator and weighed. The loss in weight of thimble was the estimate of other extract in sample.

$$\text{Fat \%} = \frac{\text{Loss in weight (g)}}{\text{Weight of sample (g)}} \times 100$$

### 3.3.3 Crude protein

The total nitrogen was estimated by Micro kjeldhal method (AOAC, 1995).

**Reagents**

i) Conc. $H_2SO_4$

ii) Boric acid (4%)

iii) NaOH (40%)

iv) N/100 HCl

v) **Mixed indicator solution:** Bromocresol green (0.5g) and methyl red (0.1g) was dissolved in 100 ml 95 per cent ethanol.

vi) **Digestion mixture:** Potassium sulphate (10g), copper sulphate (0.5g) and ferrous sulphate (2g) were mixed together.

**Procedure**

200 mg moisture free sample was taken and digested with 10 ml concentrated $H_2SO_4$ and a pinch of digestion mixture. The nitrogen as ammonical salt, was distilled with 40 per cent NaOH in a microkjeldahal apparatus. The ammonia thus liberated was absorbed in 10ml boric acid solution containing a few drops of mixed indicator and was titrated

against HCl (N/100). The end point was indicated by change of colour from bluish green to pink.

$$N\ \% = \frac{0.0014 \times \text{volume of N/100 HCl used} \times \text{volume of digested sample made}}{\text{Weight of sample} \times \text{volume of aliquot taken}}$$

$$P\ (\%) = N\% \times F$$

Where,

F = Factor for converting nitrogen to protein

### 3.3.4 Crude fibre

Crude fibre in the sample was determined using the standard method of analysis (AOAC, 1995)

**Reagents**

i) Hydrochloric acid : 1% (v/v)

ii) Sulphuric acid solution : 1.25%

iii) Sodium hydroxide solution : 1.25%

**Procedure**

Two gram of fat free sample was weighed in one litre tall beaker containing 200 ml 1.25 % $H_2SO_4$. Then it was heated to boiling in the crude fibre apparatus and kept boiling for 30 minutes under the bulb condensers. The beaker was rotated occasionally to mix the contents and to remove the particles from the side. The contents of the beaker were then filtered and then sample was washed back into the tall beaker with 200 ml 1.25% NaOH. It was again brought to boiling point and boiled exactly for 30 minutes. All the insoluble matter was transferred to the

sintered crucible by means of boiling water till acid free. It was washed thrice with alcohol followed by three times washings with acetone and dried to constant weight at $100^0$C and its weight was recorded. The crucible was kept in a muffle furnace at $550^0$C for one hour. The crucible was taken out from furnace, cooled in a dessicator and reweighed and the percentage of crude fibre in the sample was calculated.

Calculation

$$\text{Crude fibre (\%)} = \frac{W_2 - W_1}{W_1} \times 100$$

Where

$W_1$ = weight of sample (g)

$W_2$ = weight of insoluble matter (weight of crucible + insoluble matter ï weight of crucible)

$W_3$ = weight of ash (weight of crucible + ash ï weight of crucible)

### 3.3.5 Ash

Ash in the sample was determined by employing the standard method of analysis (AOAC, 1995)

**Procedure**

Five gram of oven dried sample was weighed in a pre-weighed crucible and ignited until the sample was thoroughly charred and smoke ceased out. The crucible was kept in muffle furnace ($550^0$C) for 6 hours or till a white ash was obtained. The crucible was then cooled in a dessicator and weighed. The loss in weight represented the ash content.

**Calculation**

$$\text{Crude fibre (\%)} = \frac{W_2 - W_1}{W} \times 100$$

Where

$W_2$ = weight of ash + crucible (g)

$W_1$ = weight of crucible (g)

W = weight of sample (g)

### 3.3.6 Alcohol insoluble solid (AIS)

AIS of green and dried pea were measured by method described by AOAC (1990).

**Procedure**

Placed the filter paper, whatman No. 1 in a petridish and dried at $100^0$C in oven for 20 minutes. Removed any foreign particles present in peas. Washed the peas and ground them into a smooth paste in case of fresh green peas and in dehydrated peas. Took the 5 g of fresh and dried material in the bottom flask added 100 ml of 80% alcohol. Refluxed for 30 minutes and filtered. Washed the residue on filter paper with 80% alcohol until the washing were clear of colourless. Transferred the filter paper with AIS in hot air oven and dried for 2 hours at $100^0$C. Cooled in a dessicator and weighted it. It is expressed in per cent.

$$\text{Crude fibre (\%)} = \frac{\text{Weight of residue}}{\text{Weight of sample}} \times 100$$

## 3.4 CARBODYDRATES

Total soluble sugars other than starch were extracted according to procedure of Cerning and Guilhot (1973).

Extraction

Five hundred mg of oven dried sample was taken in a round bottom flask and 25 ml ethanol (80%) was added to it. The flask was

connected to a condenser and kept on a heating mental for 30 minutes with occasional stirring. The extract was cooled, centrifuged at 8,000 rpm for 15 minutes and the supernatant was collected in a beaker. The above procedure was repeated twice, each time taking 25 ml ethanol (80%). The combined extract was kept on a boiling water bath to evaporate ethanol. The residue was dissolved in distilled water and volume was made to 50 ml.

### 3.4.1 Total soluble sugars

Total soluble sugars were estimated by the method of Yemm and Willis (1954).

Reagents

i) **Standard sugar solution:** Twenty-five mg glucose was dissolved in distilled water and volume was made to 100 ml. This solution contained 250-µg glucose per ml. For obtaining a standard curve, 0.2 ml to 1.0 ml of this solution was used.

ii) **Anthrone reagent:** 0.2% anthrone in 70% $H_2SO_4$. This reagent was prepared fresh daily and allowed to stand for one hour before use.

**Procedure**

Freshly prepared 10ml anthrone reagent was pipetted in a test tube and kept in chilled ice-cold water. One ml of the sugar extract was diluted to 10 ml with distilled water. Out of this diluted extract one ml was taken and was layered on the anthrone reagent. After cooling for five minutes, the contents were thoroughly mixed while still immersed in ice-cold water. The contents in the tube were heated vigorously in a boiling

water bath for 10 minutes, and then immediately cooled in cold water. The absorbance was read at 625 nm against a suitable blank. The amount of sugar was determined by referring to a standard curve previously prepared with glucose.

### 3.4.2 Reducing sugars

Reducing sugars were estimated by Somogyiôs modified method. (Somogyi, 1945)

**Reagents**

i) **Copper reagent A:** Twenty five gram anhydrous sodium carbonate, 25g potassium sodium tartarate, 20g sodium bicarbonate and 200g anhydrous sodium sulphate were dissolved in distilled water and made volume to one litre.

ii) **Copper reagent B:** Copper sulphate (15g) was dissolved in 100 ml distilled water containing two drops of concentrated HCl. Copper reagent A and B were mixed in the ratio of 25:1 (v.v) just before use.

iii) **Arsenomolybdate reagent :** Twenty five gram ammonium molybdate was dissolved in 450 ml distilled water by warming. Twenty ml concentrated $H_2SO_4$ was added stirring. Three-gram sodium hydrogen arsenate was dissolved in 25 ml distilled water and added with stirring. The solution was incubated at $37^0$C for 24h before use. This reagent was stored in a glass stoppered brown bottle and stored in refrigerator.

iv) **Standard sugar solution:** Twenty-five mg glucose was dissolved in distilled water and volume was made to 100 ml.

**Procedure**

One ml of extract was taken in a blood sugar tube graduated at 25 ml. One ml mixed copper reagent was added and then heated for 20 minutes in boiling water bath. To this one ml arsenomolybdate reagent was added, mixed thoroughly and diluted to 25 ml with distilled water. A stable blue colour quickly appeared which was read at 520 nm against a suitable blank. The amount of reducing sugars was determined by referring to the glucose standard curve.

### 3.4.3 Non-reducing sugars

The amount of non-reducing sugars was calculated as the difference between the amounts of total soluble sugars and reducing sugars.

### 3.4.4 Starch

Starch from the sugar free pellet obtained after centrifugation was estimated by the method of Clegg (1956).

**Reagents**

Perchloric acid (52%)

**Extraction**

Five ml distilled water was added to the aforesaid residue of test material and while stirring. 6.5 ml of 52 per cent perchloric acid was added. The contents were stirred continuously for 15 minutes. To this, 20 ml distilled water was added and centrifuged at 8000 rpm for 20 minutes. The supernatant was collected in a 100 ml volumetric flask. Five ml distilled water was then added to residue and extraction was

repeated with 52 per cent perchloric acid, stirring ocassionaly for 30 minutes. The contents of the tube were washed into a volumetric flask containing the test extract and it was diluted to 100 ml with distilled water. It was then filtered discarding first five ml of filterate. 0.1 ml of extract was used for glucose estimation, using anthrone reagent by the method of Yemm and Willis (1954)

Calculation

Starch = Glucose × 0.9

## 3.5 *IN VITRO* DIGESTIBILITY

### 3.5.1 *In vitro* protein digestibility

*In vitro* protein digestibility was estimated by the modified method of Mertz *et al.* (1983).

**Reagents**

i) **Pepsin reagent** (0.1M $KH_2PO_4$, pH 2.0, containing 0.2 per cent pepsin): Potassium phosphate (13.6g) was dissolved in one litre of water and pH of the solution was adjusted to 2.0 and then 2g pepsin (Sigma Chemical Company, USA) was dissolved in the buffer.

ii) **TCA (50%) :** Fifty gram trichloroacetic acid was dissolved in water and volume was made upto 100ml.

**Procedure**

Two hundred and fifty mg of sample was weighed and transferred to a centrifuge tube. To it 20 ml of pepsin reagent was added. The tube was stoppered and arranged in a water bath shaker and incubated at $37^0$C

for 3 hours. Then the centrifuge tube was removed, and cooled. Five ml of 50 per cent TCA was added and centrifuged the contents at 10,000 rpm for 10 minutes at room temperature and filtered. Ten ml of this aliquot was taken and dried in hot air oven. Dried aliquot was digested for nitrogen determination by microkjeldahl method (AOAC, 1995). Digested protein of sample was estimated and protein digestibility was calculated by following formula.

$$\text{Protein digestibility (\%)} = \frac{\text{Digested protein}}{\text{Total protein}} \times 100$$

### 3.5.2 *In vitro* starch digestibility

*In vitro* starch digestibility was determined by the method given by Singh *et al.* (1982).

**Reagents**

i) **0.2 M Disodium hydrogen phosphate:** Disodium hydrogen phosphate (35.598g) was dissolved in distilled water and volume was made to one litre.

ii) **0.2 M Potassium dihydrogen phosphate:** Potassium dihydrogen phosphate (27.28g) was dissolved in distilled water and volume was made upto one litre.

iii) **0.2 M Phosphate buffer (pH 6.9):** Fifty ml of 0.2M potassium dihydrogen phosphate was added to 46.8 ml 0.2 M sodium dihydrogen phosphate and volume was made upto 200 ml.

iv) **Pancreatic amylase:** Twenty mg pancreatic amylase (Sigma Chemical Company, USA) was dissolved in 50 ml phosphate buffer (pH 6.9).

v) **Dinitrosalicylic reagent:** Sodium potassium tartarate (300g), 3, 5-dinitrosalicylic acid (10g) and sodium hydroxide (16g) were dissolved in carbon dioxide free water and volume was made to one litre. The reagent was stored in brown bottle and protected from sunlight.

vi) **Standard maltose solution:** Maltose monohydrate (100mg) was dissolved in distilled water and volume made upto 100 ml.

**Procedure**

Fifty mg defatted sample was dispersed in 1.0 ml 0.2M Phosphate buffer (pH 6.9), 0.5 ml pancreatic amylase was added and incubated in water bath at $37^0$C for 2 hours with occasional shaking of the test tubes. After incubation, 2ml dinitrosalicylic reagent was quickly added and heated for 5 minutes on a boiling water bath. After cooling, the solution was made to 25 ml with distilled water and filtered through an ordinary filter paper prior to measurement of absorbance at 550nm.

A blank was run simultaneously by incubating the sample without enzyme. Dinitrosalicylic acid reagent was added before the addition of the enzyme solution. Values were expressed as mg maltose released/g sample. Standard curve was prepared by taking 0.5 to 4.0 mg maltose from a standard solution.

### 3.6 TOTAL MINERALS (Ca, Fe and Zn)

One gram ground sample was taken in a 150 ml conical flask. To this, 25-30 ml diacid mixture (Nitric acid: Perchloric acid :: 5:1, v/v) was added and kept overnight. The contents were digested by heating till clear white precipitate settled down at the bottom. The crystals were dissolved in double distilled water. The contents were filtered through Whatman

No. 42 filter paper. The filtrate was made to 50 ml with double distilled water and used for determination of total calcium, iron and zinc.

Minerals including calcium, iron and zinc in acid digested samples were determined by atomic absorption spectrophotometer according to the method of Lindsey and Norwell (1969).

## 3.7 ANTI-NUTRITIONAL FACTORS

### 3.7.1 Phytic acid

Phytic acid was determined by the method of Davies and Reid (1979).

**Reagents**

i) **Nitric acid (0.5M):** Nitric acid (69.5%) 15.96 ml (AR grade, sp. gr. 142) was diluted to 500 ml with distilled water.

ii) **Ferric ammonium sulhate :** Ferric ammonium sulphate (215 mg) was dissolved in distilled water. Few drops of HCl were added to it and volume was made to 500 ml with distilled water.

iii) **Ammonium thiocyanate (10%) :** Ten gram ammonium thiocyanate was dissolved in distilled water and volume was made to 100 ml.

iv) Iso-amyl alcohol.

v) **Sodium phytate :** Sodium phytate (35.54 mg, 5.5% $H_2O$, 97% purity and containing 12 Na/mole) was dissolved in 100 ml of 0.5 M $HNO_3$. A solution containing 200 µg phytic acid/ml was obtained.

**Extraction**

Five hundred mg sample was extracted with 20 ml 0.5 M $HNO_3$ for 3 hours with continuous shaking on a shaker at room temperature. The contents were centrifuged at 800 rpm for 15 minutes. Supernatant was used for estimation of phytic acid.

**Procedure**

In a test tube, 1.0 ml $HNO_3$ extract was taken and volume was made to 1.4 ml with water. To it added one ml ferric ammonium sulphate solution and the contents were thoroughly mixed and placed in a boiling water bath for 20 minutes. Cooled the tubes immediately to room temperature under running tap water. Five ml Iso-amyl alcohol was added and the contents were mixed vigorously and added 0.1 ml ammonium thiocyanate solution. The tubes were shaken well and centrifuged at 3000 rpm for 10 minutes. Colour intensity in the alcohol was read at 465 nm against iso-amyl alcohol blank exactly after 15 minutes of addition of ammonium thiocyanate.

For plotting a standard curve 0.2 to 1.4 ml standard phytate solution containing 40 to 280 µg phytic acid was taken and made to 1.4 ml with distilled water.

### 3.7.2 Polyphenols

The polyphenolic compounds were extracted from the sample by the method of Singh and Jambhunathan (1981).

**Extraction**

500 mg defatted sample was refluxed with 50 ml methanol containing one per cent HCl for four hours. The extract was concentrated by evaporating methanol on a boiling water bath and made its volume to

25 ml with methanol HCl solution. The amount of polyphenolic compounds were estimated as tannic acid equivalent according to Folin-Denis procedure. (Swain and Hills, 1959).

**Reagents**

(i) Folin-Denis reagent: Sodium tungstate (100g), phosphomolybdic acid (20g), 50 ml phosphoric acid were added to 750 ml distilled water and refluxed for two hours, cooled and diluted it to one litre and stored in brown bottle.

(ii) Tannic acid solution: Tannic acid (100 mg) was dissolved in water and volume made to one litre. Twenty ml of this stock solution further diluted to 100 ml with water to give a working standard solution containing 20 µg tannic acid per ml.

(iii) Saturated sodium carbonate solution.

**Procedure**

0.2 ml of the extract was diluted to 8.5 ml with distilled water in a graduated test tube. After thorough mixing, 0.5 ml Folin-Denis reagent was added and the tubes were shaken well. Exactly 3 minutes, one ml saturated sodium carbonate solution was added and tubes were thoroughly shaken again. If the solution was cloudy or precipitates appeared, it was centrifuged before faking readings.

A standard curve was plotted by taking 0.5 to 3.0 ml of working tannic acid standard solution containing 10 to 60 µg tannic acid.

## 3.8 VITAMINS

**3.8.1 β-carotene** in the sample was separated by column chromatography and estimated colorimetrically according to the standard method of analysis (AOAC, 1995).

**Reagents**

i) 3 % acetone in petroleum ether

ii) Alumina (aluminum oxide neutral)

iii) Sodium sulphate anhydrous

iv) **ß-carotene standard –** Fifty mg ɓ-carotene was dissolved in three percent acetone in petroleum ether and diluted to 50 ml (1mg/ml).

**Procedure**

**Preparation of chromatography column**

The chromatography column was filled with aluminium oxide which had been dried in oven at $70^0$C. The adsorbent was gently pressed down to a depth of 10 cm of tapping or suction. The absorbent was covered with a one cm layer of anhydrous sodium sulphate. The column was wetted with 3 per cent in petroleum ether. The column was not allowed to dry at any stage.

**Extraction of sample**

Fresh plant material was finely cut. Ten gram fresh or 5g dried sample was weighed, 30ml of three per cent acetone in petroleum ether was added to it and allowed to stand overnight or homogenized in a high speed blender after adding 5g sodium sulphate anhydrous. The extract was then filtered and residue was washed with three per cent acetone in petroleum ether untill the filterate was of clear yellow colour. The filterate was pooled and taken in a 500 ml separating funnel. It was then shaken with 50 ml water. Washing were discarded. It was repeated 2-3 times in order to make it acetone free. The solvent was then dried over

anhydrous sodium sulphate and was diluted to 100 ml with petroleum ether.

**Chromatographic separation of β-carotene:** Ten ml extract was taken and concentrated to 2 ml. The concentrated extract was poured into adsorption column followed by 10 ml three per cent acetone petroleum ether. The elute containing all the ϐ-carotene was collected and transferred to 25 ml volumetric flask and volume was made with 3 per cent acetone in petroleum ether.

**For standard curve:** Standard solution (0.2 to 2.0 ml) was taken in 25 ml volumetric flask and volume was made with three per cent acetone petroleum ether. The intensity was read at 435 nm by using Spectronic 21.

**Calculation**

$$\text{ϐ-carotene (mg/100g)} = \frac{M \times V_1 \times 100}{V_2 \times W}$$

**Where,**

M = Concentration of extract elute obtained from graph

W = Weight of sample

$V_1$ = Volume of extract made

$V_2$ = Volume of extract taken for elution

### 3.8.2 Ascorbic acid

Ascorbic acid in the sample was analyzed by standard method of analysis (AOAC, 1995).

**Reagent**

i) **Metaphosphoric acetic acid solution:** Fifteen g of glacial metaphosphoric pellets were dissolved in 40 ml acetic acid and 200 ml water and made volume to 500 ml with water. It was filtered rapidly in a dark coloured bottle.

ii) **Ascorbic acid standard solution (1mg/ml):** Fifty mg ascorbic acid standard that has been stored in a dessicator away from sunlight was weighed and transferred to 50 ml volumetric flask and volume was made with metaphosphoric acetic acid solution.

iii) **Indophenol standard solution :** Fifty mg of 2, 6-dichloro-indophenol that had been stored in dessicator away from sunlight over soda lime was dissolved in 50 ml water and 42 mg sodium bicarbonate was added, shaked vigorously and diluted to 200 ml with water, filtered and was stored in amber glass bottle.

**Procedure:**

**Extraction**

a) **For dry materials:** To 5g sample 50 ml of metaphosphoric acetic acid solution was added. The sample was ground gently in a pestle and mortar and pH was adjusted to 1.2. The sample was macerated until it was in suspension. Then it was filtered rapidly through Whatman No. 1 filter paper and diluted to 100 ml with metaphosphoric acid reagent.

b) **For fruit and vegetable juices:** The juice of fruits was extracted by pressing and squeezing well pulped fruit and then it was filtered rapidly. The extracted juice was added to equal volume of $HPO_3$-$CH_3COOH$ and total volume was designated.

**Determination**

1) Two ml aliquot ascorbic acid standard solution was taken in triplicate in each of 50 ml conical flask containing 5 ml metaphosphoric acid solution.

2) It was then rapidly titrated with indophenol solution until light but distinct rose pink colour persisted for more than 5 seconds (generally 15 ml dye solution is required for it).

3) Similarly 7 ml of metaphosphoric acetic acid solution was taken in a conical flask. The water equal to volume of indophenol used against standard was added and then titrated for blank. Three reading were taken.

4) Two ml sample aliquot was taken in a conical flask containing 5 ml metaphosphoric acetic acid solution. It was titrated against the solution and similarly three reading were taken.

**Calculation**

$$\text{Ascorbic acid (mg/100g)} = \frac{Y - B}{X - B} \times \frac{V}{W} \times 100$$

Where

Y = Volume of dye solution used against sample aliquot

B = Volume of dye solution used against blank.

X = Volume of dye solution used against standard

V = Volume of aliquot made

W = Weight of sample

## 3.9 PIGMENT

### 3.9.1 Total chlorophyll

Total chlorophyll was determined as per the method described by Amar Singh (1977).

**Procedure**

Peas sample (1-2 g) was taken and extracted in 80 per cent acetone in mortar pestle till it became colourless. A small amount of $CaCo_3$ was added as stabilizer while extracting. Decantation of extracted sample was continued till it become colourless. The extract was filtered through filter paper and the volume of extract was adjusted to 100 ml by repeated washing of material with 80 per cent acetone. The optical density of extract was measured at 663 nm and 645 nm. The total chlorophyll as mg per gm of sample was calculated by using following formula:

$$\text{Total chlorophyll} = \text{O.D. at 645 nm} + \text{O.D. at 633 nm} \times \frac{V \times W}{1000\ (mg/g)}$$

Where,

O.D. = Optical density

V = Final volume of extract with 80% acetone

W = Dry weight of fresh sample (gm)

## 3.10 DEVELOPMENT OF PRODUCTS FROM PEA

Different varieties of pea were utilized for the development of curry vegetables and dry vegetables. Recipe is given below :

### 3.10.1 Curry vegetable (pea)

**Ingredient**

| | | |
|---|---|---|
| Pea | : | 100 g |
| Potato | : | 50g |
| Tomato | : | 50 g |
| Onion | : | 50 g |
| Garlic | : | 2-3 cloves |
| Ginger | : | small piece |
| Red chilli powder | : | ¼ tsp |
| Garam masala | : | ¼ tsp |
| Salt | : | to taste |
| Oil | : | 15 ml |
| Coriander leaves (chopped) | : | 1/4 tsp |

**Method**

- Finely ground onion, tomato, ginger and garlic separately.
- Heated oil in a pan and added cumin seeds followed by garlic-ginger paste, onion paste and fried till golden brown.
- Added tomato paste and all other pieces and cooked till tomatoes were soft, then poured one cup water and cooked on slow flame for thickening of gravy.
- Added washed pea grains and sliced potatoes and cooked for 5 minutes.
- After this removed from flame and garnished with chopped coriander leaves.

### 3.10.2 Dry vegetable (pea)

**Ingredients**

| | | |
|---|---|---|
| Pea | : | 100 g |
| Potatoes | : | 50 g |
| Tomato | : | 50 g |
| Onion | : | 50 g |
| Garlic | : | 2-3 cloves |
| Ginger | : | small piece |
| Red chilli powder | : | ¼ tsp |
| Dry coriander powder | : | ¼ tsp |
| Cumin seeds | : | ¼ tsp |
| Garam masala | : | ¼ tsp |
| Amchur powder | : | ¼ tsp |
| Salt | : | to taste |
| Oil | : | 10 ml |

**Method**

- Washed pea grains.
- Chopped onion and tomato finely.
- Heated oil in a pan and sauted cumin seeds followed by ginger and garlic paste.
- Added chopped onion and fried till golden brown.
- Mixed all the spices and tomatoes and cooked for 4-5 minutes.
- Added pea grains and sliced potatoes and cooked on slow flame for 15 minutes till completely done.
- Garnished with coriander leaves.

## 3.11 ORGANOLEPTIC EVALUATION

The curry and dry vegetable prepared from pea were evaluated for organoleptic acceptability by a panel of 10 judges selected from I.C. College of Home Science, CCS Haryana Agricultural University, Hisar. The judges were asked to record the quality characteristics viz. colour, appearance, flavour, texture and taste using a 9-point hedonic rating scale as given in Appendix-I. Average of the scores for all these characteristics were expressed as overall acceptability.

## 3.12 PROCESSING OF PEA

### 3.12.1 Dehydration of pea

#### 3.12.1.1 Sun drying

Green peas after depodding were washed in running water, soaked for 30 minutes in two per cent $Na_2CO_3$ solution, washed free of carbonate and then blanched in boiling water containing 0.4 per cent potassium metabisulphite (KMS), 0.1 per cent $Na_2CO_3$ and MgO for 3 minutes. In direct sun drying, the material was spread on aluminium trays and exposed directly to sunôs rays in the open. The dehydrated sample was then cooled in dessicator and packed in polyethylene packets and sealed and stored for 90 days at room temperature.

#### 3.12.1.2 Oven drying

The treated pea samples were dried in oven at 50-60$^0$C for 5-6 hours till completely dried. The dehydrated sample was then cooled in dessicator and packed in polyethylene packets and sealed and stored for 90 days at room temperature.

### 3.12.2 Freezing for pea

Green peas after depodding were blanched in ammonium bicarbonate solution (0.2% w/v, 97.5$^0$C) and 0.002% magnesium chloride. The blanched pea samples (250g) were packed in polythene bags and then frozen in airblast freezer at ï 30$^0$C for 8 hours. Subsequently these samples were stored in deep freezer at ï 20$^0$C for 3 months. Dehydrated and frozen peas were evaluated for following parameters at 0, 1, 2 and 3 months.

## 3.13 COOKING QUALITY

**Swelling capacity:** Fifty-gram pea grains were counted and their volume was noted in graduated cylinder. These grains were soaked in 150 ml water for overnight soaked overnight. Swelling capacity per grain was determined by using the following formula:

$$\text{Swelling capacity} = \frac{\text{Volume after soaking ï Volume before soaking}}{\text{No of grains}}$$

**Hydration capacity :** Fifty gram pea grains were counted and transferred to a measuring cylinder and 50 ml water was added. The cylinder were covered with aluminium foil and left overnight at room temperature. Next day water was drained off and superfluous water was removed with filter paper and swollen grains reweighted. Hydration capacity per seed was determined by using the following formula:

$$\text{Hydration capacity per seed} = \frac{\text{Weight of soaked grains ï Weight of grains before soaking}}{\text{No of grains}}$$

**Cooking time:** (50g) grains were taken in beakers fitted with condensers to avoid evaporation during boiling. Water was added in a ratio of 1:4 (w/v). Samples were stirred at one minuteôs interval. After 2 minute one grain was withdrawn without interupting the boiling. Degree of cooking was tested by pressing grains between fingers. If grains were felt uncooked, on grain was again tested after 2 minute. This procedure continued until five grains tested were found cooked. At this time total cooking time was recorded.

**Soaking:** Pea grains were soaked in distilled water (grain: water, 1:4 (w/v) for 12 h at $37^0$C. The soaking water was drained off. The soaked grains were washed twice using distilled water.

### 3.14 NUTRITIONAL EVALUATION

The dehydrated pea at each storage interval (0,30, 60 and 90 days) was ground in an electric grinder and packed in polypack. The ground sample was analyzed for parameters namely proximate composition, minerals, vitamin, pigments and *in vitro* digestibility by the methods mentioned earlier in 3.4-3.9. The frozen sample was thawed at room temperature and dried in oven at $50^0$C for 24 hours and then ground in an electric grinder. The ground sample was then analyzed for proximate composition, minerals, vitamins, pigments and *in vitro* digestibility by the methods mentioned earlier in 3.4-3.9.

## 3.15 ORGANOLEPTIC EVALUATION

The frozen sample was kept at room temperature for 30 minutes for thawing and dehydrated sample was soaked overnight for the development of curry and dry vegetable by method as mentioned earlier in 3.10. All the products were evaluated organoleptically by a panel of 10 judges using 9-point hedonic rating scale.

## 3.6 STATISTICAL ANALYSIS

The data was subjected to statistical analysis of variance in a complete randomized design according to standard method (Panse and Sukhatme, 1961).



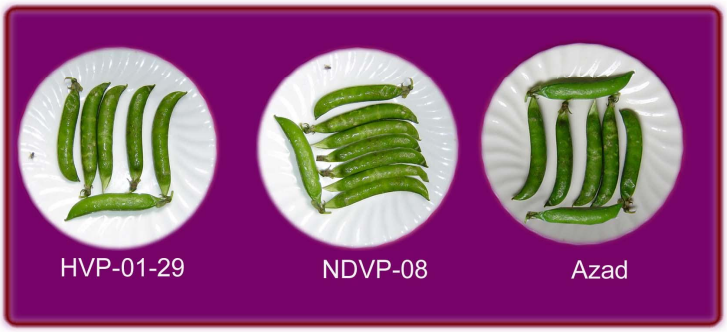



Plate-1 : Pea Varieties

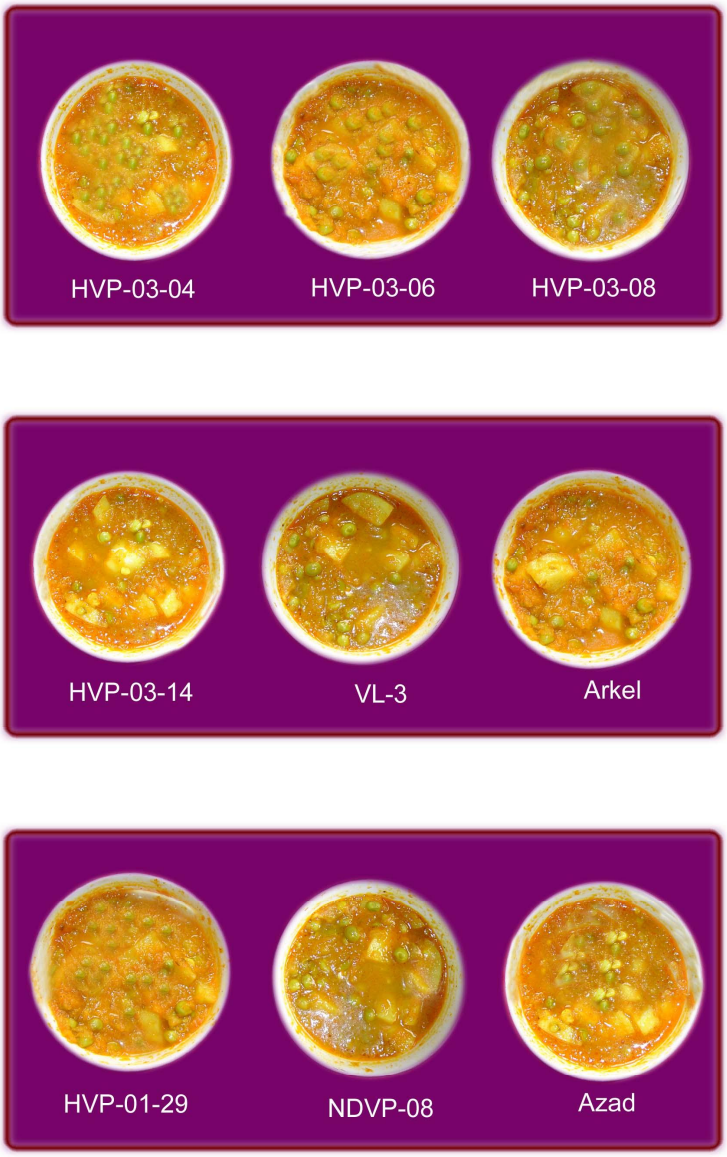
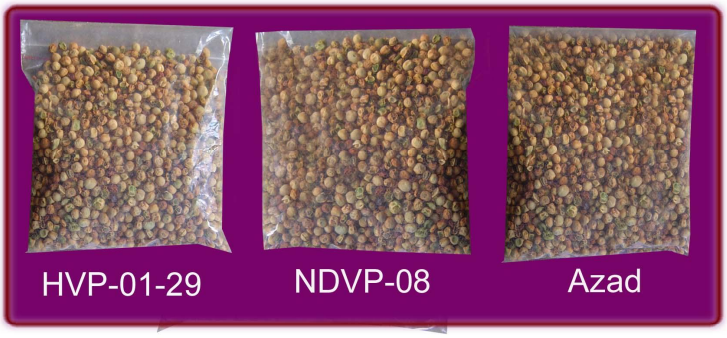



Plate 2: Curry vegetables prepared from fresh pea varieties


Plate 3 : Dry vegetables prepared from pea varieties

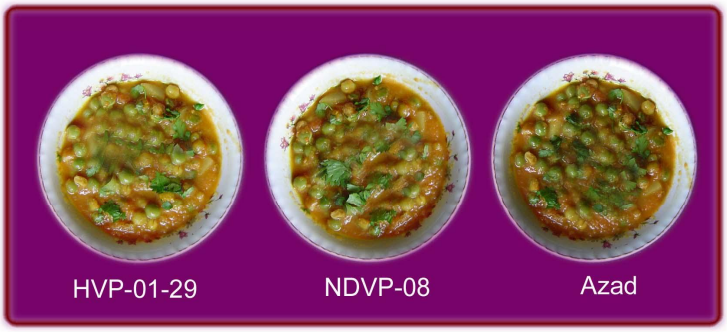

Frozen




Sun dried

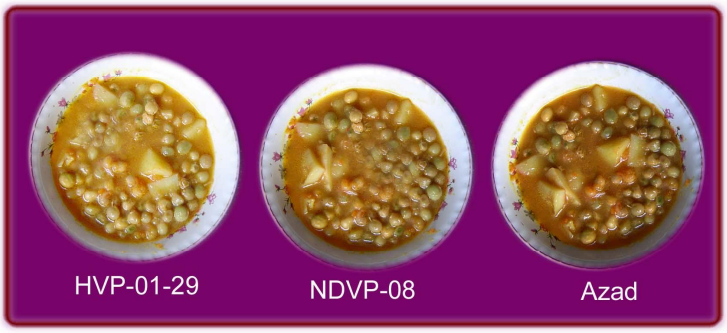

Oven dried

Plate 4 : Processed pea varieties



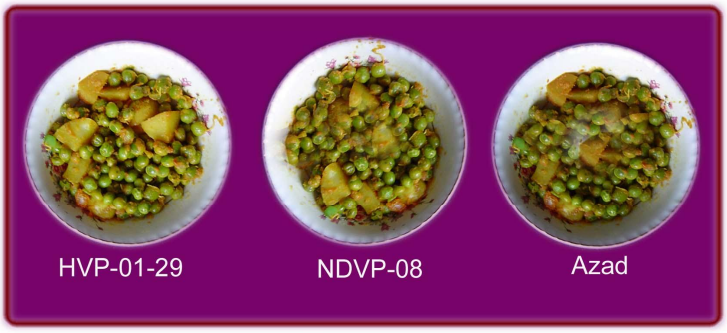

Frozen


Sun dried



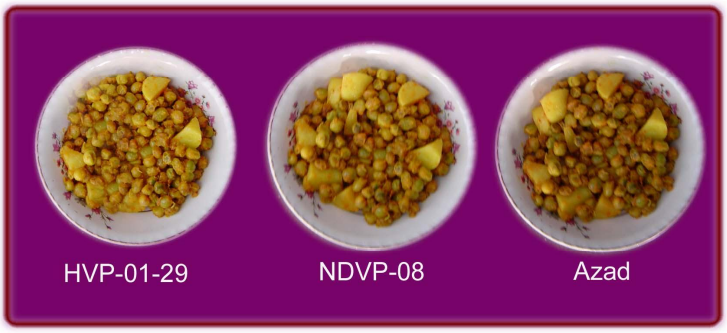

Oven dried

Plate 5 : Curry vegetables prepared from processed peas




Frozen


Sun dried




Oven dried

Plate 6 : Dry vegetables prepared from processed peas

**CHAPTER-IV**

# *Results and Discussion*

The present study was conducted to evaluate the physical and nutritional parameters of pea varieties.on the basis of physical properties, nutritional composition and acceptability trial, the pea varieties found best were subjected to processing method i.e. dehydration (sun drying and oven drying) and freezing to increase their shelf life and effect of storage on their chemical composition was studied .The results of the present study are discussed under the following heads:

4.1 Physical properties

4.2 Nutritional evaluation of pea

4.3 Organoleptic evaluation of curry and dry vegetable

4.4 Processing of pea for extending shelf life

4.4.1 Cooking quality of frozen and dried peas

4.4.2 Organoleptic evaluation of curry and dry vegetable prepared from frozen and dried peas

4.4.3 Nutritional evaluation of frozen and dried peas

## 4.1 PHYSICAL PROPERTIES

Physical parameters of pea varieties were analyzed and results of the same are presented below:

### 4.1.1 Pod length

Pod length of pea varieties ranged from 85.5 to 100.7 mm Highest pod length i.e. 100.7 mm was observed in NDVP-08 and lowest pod length i.e. 86.3 mm in Arkel variety. Pod length was similar in HVP-03-04, Arkel and VL-3 varieties and showed non-significant differences among themselves. Pod length was also similar in HVP-03-04, HVP-03-14 and HVP-01-29 varieties. The values of pod length observed in the study were higher as compared to the reported value of 43.10 and 69.50 mm (Pawar *et al.* 1994). Das *et al.* (1992) reported that pod length of various pea varieties ranged from 77.30 to 93.20 mm. Pan and Prasad (2000) reported value of pod length, which varied from 79.8 to 84.2 mm (Table 4.1).

### 4.1.2 Pod width

Pod width ranged from 16.20 to 22.60 mm in pea varieties (Table 4.1). Pod width was highest in HVP-01-29 variety i.e. 22.60 mm whereas lowest pod width was found in Arkel variety i.e. 16.20 mm. Pod width was similar in HVP-03-04, HVP-03-08, HVP-03-14 and NDVP-08 varieties. Pod length was also similar in three varieties i.e. HVP-01-29, VL-3 and Azad and showed non-significant differences among themselves. According to the results of Pawar *et al.* (1994) pod width of different varieties of pea ranged from 9.96 to 12.62 mm. According to an earlier study of Pan and Prasad (2000) pod width of different pea varieties has been reported to be in range of 13.7 to 14.7 mm.

**Table 4.1: Physical properties (per pod) of pea varieties**

| Variety | Pod length (mm) | Pod width (mm) | Pod thickness (mm) | Pod weight (g) | Grain weight (g) | Shell weight (g) | Shelling percentage (%) | Pea grain to shell ratio |
|---|---|---|---|---|---|---|---|---|
| HVP-03 ï 04 | 86.3±0.04 | 19.6±0.03 | 15.7±0.03 | 3.52±0.07 | 1.66±0.07 | 1.50±0.05 | 47.07±1.20 | 1.10±0.02 |
| HVP-03 ï 06 | 92.9±0.02 | 18.7±0.01 | 14.6±0.02 | 4.87±0.25 | 2.63±0.16 | 2.40±0.15 | 56.40±4.06 | 1.19±0.10 |
| HVP-03 ï 08 | 90.4±0.08 | 19.3±0.01 | 16.1±0.04 | 4.63±0.12 | 2.05±0.02 | 1.94±0.02 | 44.62±0.99 | 1.08±0.01 |
| HVP-03 ï 14 | 92.2±0.04 | 18.9±0.01 | 14.7±0.02 | 4.77±0.04 | 2.53±0.07 | 2.36±0.04 | 53.13±2.04 | 1.06±0.02 |
| HVP-01 ï 29 | 92.7±0.03 | 2.2.6±0.03 | 15.8±0.02 | 4.32±0.04 | 2.00±0.06 | 1.84±0.21 | 46.35±0.97 | 1.09±0.02 |
| Arkel | 8.5.5±0.12 | 16.2±0.03 | 16.5±0.02 | 4.73±0.07 | 2.52±0.07 | 2.28±0.04 | 53.38±0.67 | 1.09±0.01 |
| VL-3 | 86.3±0.05 | 21.4±0.08 | 17.5±0.02 | 4.94±0.02 | 2.25±0.03 | 2.03±0.04 | 52.22±0.27 | 1.10±0.01 |
| Azad | 88.7±0.03 | 20.9±0.02 | 15.3±0.01 | 4.06±1.10 | 1.87±0.03 | 1.68±0.32 | 46.18±0.02 | 1.11±0.01 |
| NDVP-08 | 100.7±0.09 | 19.7±0.06 | 19.2±0.02 | 5.20±0.11 | 2.78±0.03 | 2.64±0.02 | 52.93±0.37 | 1.05±0.01 |
| CD (P<0.05) | 0.20 | 0.13 | 0.07 | 0.34 | 0.22 | 0.18 | 5.07 | N.S. |

Values are mean ± SE of 25 observations

### 4.1.3 Pod thickness

Among selected nine pea varieties, lowest pod thickness i.e. 14.60 mm was observed in HVP-03-06 variety while highest value of 19.20 mm was estimated in variety NDVP-08 (Table 4.1). Pod thickness was similar in HVP-01-04, HVP-01-29, Arkel and Azad pea varieties. Pod thickness was also similar in HVP-03-06 and HVP-03-14 varieties. Non-significant difference in pod thickness was observed in HVP-03-08, VL-3 and NDVP-08 varieties. According to an earlier study of Pawar *et al.* (1994) pod thickness of different varieties of pea has been reported to be in range of 10.93 to 15.56 mm. Das *et al.* (1992) reported that pod thickness of pea varieties ranged from 11.70 to 17.60 mm.

### 4.1.4 Pod weight

Pod weight of pea varieties varied from 3.52 to 5.20 g (Table 4.1). NDVP-08 was having the maximum pod weight and variety HVP-03-04 was having the minimum pod weight. Pod weight was similar in variety HVP-03-06, HVP-03-08, HVP-03-14, Arkel and VL-3. Non-significant difference was observed in variety HVP-01-29 and Azad. Pod weight significantly differed among the varieties i.e. HVP-03-04, Azad and NDVP-08. Pawar *et al.* (1994) quoted the value of pod weight of various pea varieties ranging from 2.25 to 4.72 g.

### 4.1.5 Grain and Shell weight

Grain weight ranged from 1.66 to 2.78 g in selected pea varieties (Table 4.1). Highest grain weight was observed in NDVP-08 variety i.e. 2.78 g and lowest grain weight was observed in variety HVP-03-04 i.e. 1.66 g. Grain weight was similar in variety HVP-03-06, Arkel, HVP-03-

14 and NDVP-08. Grain weight was similar in HVP-03-08 and HVP-01-29 varieties. Shell weight ranged from 1.50 to 2.64 g among different pea varieties. Shell weight was similar in HVP-03-06, HVP-03-14 and Arkel varieties. Shell weight was similar in HVP-01-29 and Azad pea varieties and showed non-significant differences among themselves. Significant differences in shell weight were observed among the varieties namely HVP-03-04, VL-3 and NDVP-08. According to an earlier study of Pawar *et al.* (1994) the grain weight and shell weight of different varieties of pea were reported to be in the range of 1.23 to 2.44 g and 1.02 to 2.28 g, respectively (Table 4.1).

### 4.1.6 Shelling percentage and pea grain to shell ratio

Shelling percentage of pea varieties varied from 46.18 to 56.40 per cent. Shelling percentage of varieties HVP-03-06, HVP-03-14, Arkel, VL-3 and NDVP-08 was almost similar and showed non-significant difference among themselves. Shelling percentage was similar in HVP-03-08, HVP-01-29 and Azad pea varieties. Pea grain to shell ratio ranged from 1.05 to 1.19. Pea grain to shell ratio of all pea varieties was almost similar. Pan and Prasad (2000) obtained shelling percentage of 43.40 to 48.80 per cent in different pea varieties. Shelling percentage of various pea genotypes was recorded as 43.40 to 48.80 per cent (Pan and Prasad, 2000). Pea grain to shell ratio was reported as 1.07 to 1.37 per cent by Pawar *et al.* (1994). Khurdiya *et al.* (1992) obtained lower shelling values of 37.00 ï 39.35 in some pea varieties (Table 4.1).

## 4.2 NUTRITIONAL EVALUATION

All the selected pea varieties were analyzed for proximate composition, carbohydrates, *in vitro* protein and starch digestibility, total minerals, antinutrients, vitamins and pigments. The results obtained are presented and discussed as under:

### 4.2.1 Proximate composition

**Moisture:** Moisture content of pea varieties ranged from 74.31 to 78.30 per cent. Variety VL-3 was observed to contain highest moisture content whereas lowest moisture content was found in Azad variety. Moisture content of pea varieties differed significantly among different varieties (Table 4.2 and Fig. 1). Pawar *et al.* (1994) reported moisture content of pea varieties, which varied from 71.25 to 73.65 per cent. Whereas according to Das *et al.* (1992) moisture content of different pea varieties ranged from 80.20 to 88.90 per cent. Almost similar findings in moisture content (71.25 ï 79.97%) has been reported by Michael Eskin (1984).

**Fat:** Fat content of selected pea varieties varied from 2.97 to 3.80 per cent. Azad variety contained minimum amount of fat while variety HVP-03-04 was having the maximum amount of fat. Fat content was similar in HVP-03-04, HVP-03-06 and HVP-03-08 varieties (Table 4.2). Non-significant difference in fat content was also noted among the varieties i.e. HVP-03-14, HVP-01-29, VL-3, Azad and NDVP-08 (Fig. 1). Lower fat content (0.60 ï 2.79 g %) than present finding has been reported by some workers (Bishnoi, 1991; Das *et al.* 1993).

**Table 4.2 : Proximate composition (%, dry matter basis) of pea varieties**

| Variety | Moisture | Fat | Crude Protein | Ash | Crude Fiber | Alcohol Insoluble Solid | |
|---|---|---|---|---|---|---|---|
| | | | | | | Fresh Basis | Dry Basis |
| HVP-03 ï 04 | 75.98±0.00 | 3.80±0.02 | 21.89±0.02 | 3.78±0.14 | 8.33±0.01 | 13.95±0.02 | 56.81±0.00 |
| HVP-03 ï 06 | 75.89±0.00 | 3.62±0.15 | 22.33±0.02 | 3.10±0.00 | 8.32±0.01 | 13.90±0.02 | 57.91±0.00 |
| HVP-03 ï 08 | 76.01±0.00 | 3.68±0.04 | 22.55±0.03 | 4.77±0.05 | 8.04±0.03 | 13.95±0.02 | 56.90±0.00 |
| HVP-03 ï 14 | 76.39±0.00 | 3.32±0.20 | 22.32±0.03 | 3.96±0.02 | 8.98±0.01 | 14.85±0.02 | 57.98±0.00 |
| HVP-01 ï 29 | 78.00±0.00 | 3.05±0.03 | 24.61±0.06 | 4.86±0.04 | 9.23±0.06 | 15.35±0.17 | 58.10±0.00 |
| Arkel | 77.10±0.00 | 2.36±0.02 | 21.61±0.06 | 4.76±0.03 | 10.34±0.02 | 14.09±0.04 | 57.19±0.00 |
| VL-3 | 74.31±0.00 | 3.11±0.06 | 21.04±0.03 | 3.52±0.16 | 9.52±0.05 | 13.87±0.02 | 56.31±0.00 |
| Azad | 78.30±0.00 | 2.97±0.03 | 25.11±0.03 | 4.98±0.02 | 8.00±0.03 | 15.77±0.00 | 60.51±0.00 |
| NDVP-08 | 77.60±0.00 | 3.28±0.00 | 24.65±0.07 | 4.89±0.07 | 8.35±0.02 | 15.04±0.00 | 60.15±0.04 |
| CD (P<0.05) | 0.01 | 0.27 | 0.13 | 0.24 | 0.10 | 0.18 | 0.04 |

Values are mean ± SE of three independent determination

**Crude protein:** Protein content in nine selected pea varieties was found to be from 21.04 to 25.11 per cent. Highest protein content (Table 4.2) was found in Azad variety (25.11%) followed by NDVP-08 (24.65%) and HVP-01-29 (24.61%). Protein content was almost similar in HVP-03-06 and HVP-03-14 varieties (Fig. 1). Protein content was found to be similar in HVP-01-29 and NDVP-08 varieties and showed non-significant differences among themselves. While the crude protein content differed significantly in the varieties i.e. HVP-03-04, HVP-03-08, Arkel, in VL-3 and Azad.

Almost similar finding (15.00ï 32.50%) have been reported by Deo (1987), Johns (1987), Gurguen and Barbet (1988), Savage and Deo (1989), Saharan (1991), Gdala *et al.* (1992), Shukla and Kohli (1992), Das *et al.* (1993), Gatel (1994), Zdunczyk *et al.* (1997) and Black (1998). In an earlier study of Sheriful (2002) protein content in various pea varieties ranged from 22.63 to 25.41 percent.

**Ash:** Ash content in Azad pea variety was highest and found to be 4.98 per cent followed by NDVP-08 (4.89%) and HVP-01-29 (4.86%). Lowest ash content was found to be in variety HVP-03-06 i.e. 3.10 per cent (Fig. 1). Ash content was similar in HVP-03-08, HVP-01-29, Arkel, Azad and NDVP-08 varieties. Non-significant differences in ash content among varieties HVP-03-04 and VL-3 were also noted. Results of present study are also supported by Bishnoi (1991), Das *et al.* (1993) and Pawar *et al.* (1994) and ash content was reported to be ranged from 2.95 to 4.71 per cent. Almost similar ash content (3.27 - 4.08 %) for various pea varieties has been reported by Sheriful (2002).

**Crude fibre:** Crude fibre content in nine pea varieties ranged from 8.00 ï 10.34 per cent. Crude fibre content of Azad pea variety was lowest

(8.00%) than other pea varieties (Table 4.2 and Fig. 1). Fibre content was similar in HVP-03-04 and HVP-03-06 varieties. There was a non-significant difference in crude fibre content among the varieties HVP-03-08 and Azad. Crude fibre content of HVP-03-14, HVP-01-29, Arkel, VL-3 and NDVP-08 varied significantly. The values of fibre content are within the range reported earlier for peas by Evans and Boulter (1980), Reichert and Mackenzie (1986), Welch and Griffiths (1984), Lopez *et al.* (1986), Gurguen and Barbot (1988) and Sawage and Deo (1989). Slightly lower values for fibre content (7.09-8.38%) are given by Sheriful (2002).

**Alcohol insoluble solid:** Alcohol insoluble solid content (on fresh matter basis) of pea varieties ranged from 13.87 to 15.77 per cent. Alcohol insoluble solid was found to be maximum in Azad pea (15.77%), followed by HVP-01-29 (15.35%) and NDVP-08 (15.04%)variety (Table 4.2 and Fig. 1). Alcohol insoluble solid content was recorded to be similar in HVP-03-04, HVP-03-06, HVP-03-08 and VL-3 varieties and showed non-significant differences among themselves. Non-significant differences among alcohol insoluble solid content were also noted in HVP-03-14, HVP-01-29, Arkel, Azad and NDVP-08 varieties. The AIS content obtained in present study is in agreement with the earlier reported value of 15.12 to 18.29 per cent (Kalra *et al.* 1986). Sheriful (2002) obtained AIS content as 11.45 to 13.05 percent in various pea cultivars.

Alcohol insoluble solid content (on dry matter basis) varied from 56.31 per cent to 60.51 per cent. Azad pea (60.51%) contained maximum amount of alcohol insoluble content (Table 4.2) followed by NDVP-08 (60.15%) and HVP-01-29 (58.10%). Alcohol insoluble solid content among all the varieties differed significantly ($P<0.05$). The alcohol insoluble content obtained in present study is supported by study of Kalra *et al.* (1986).

### 4.2.2 Carbohydrate

**Starch:** Starch content of pea varieties varied from 50.98 to 60.10 per cent. Perusal data in Table 4.3 (Fig. 2). revealed that starch content of variety HVP-01-29 was lowest (53.02%) followed by NDVP-08 (52.31%) and Azad (50.98%). Starch content was similar in HVP-03-06 and HVP-03-08 varieties. There was non-significant difference in the starch content among the varieties i.e. HVP-03-14, Arkel and VL-3. Starch content of HVP-03-04, HVP-01-29, Azad and NDVP-08 varieties differed significantly. Results of present study are in agreement with the results of earlier studies carried out by Das *et al.* (1993), Periago *et al.* (1996) and Panwar (1999). Starch content was found to vary from 20.54 to 23.36 percent in fresh peas of different cultivars of M1 maturity (Sheriful, 2002).

**Total soluble sugars:** The data presented in Table 4.3 reveals that among pea varieties maximum amount of total soluble sugars was found to be highest in Azad variety (8.01%) followed by NDVP-08 (7.91%) and HVP-01-29 (7.50%) (Fig. 2). Total soluble sugar was similar in HVP-03-04, HVP-03-06 and HVP-03-08 varieties. Non-significant differences in total soluble sugar content were observed in HVP-03-14, Arkel, and VL-3 varieties. The results of present study are in confirmation with the results of study of Das *et al.* (1993), Bishnoi (1991) and Panwar (1999) in which the total soluble sugar content ranged from 5.81 to 30.00 per cent.

**Table 4.3: Carbohydrate content (g/100g, dry matter basis) of pea varieties**

| Variety | Starch | Total Soluble sugars | Reducing sugars | Non-reducing sugars |
|---|---|---|---|---|
| HVP-03-04 | 22.65±0.02 | 14.96±0.02 | 2.81±0.01 | 12.15±0.03 |
| HVP-03-06 | 23.38±0.01 | 14.78±0.01 | 2.75±0.02 | 12.03±0.00 |
| HVP-03-08 | 23.07±0.01 | 14.41±0.00 | 2.94±0.02 | 11.47±0.03 |
| HVP-03-14 | 21.57±0.18 | 14.94±0.01 | 2.85±0.03 | 12.09±0.04 |
| HVP-01-29 | 21.19±0.01 | 15.41±0.00 | 3.13±0.01 | 12.28±0.02 |
| Arkel | 25.38±0.01 | 14.95±0.03 | 2.93±0.03 | 12.02±0.00 |
| VL-3 | 25.81±0.02 | 13.36±0.26 | 2.06±0.02 | 11.30±0.01 |
| Azad | 20.42±0.34 | 16.16±0.02 | 3.26±0.15 | 12.90±0.00 |
| NDVP-08 | 20.56±0.01 | 15.05±0.03 | 3.06±0.02 | 11.79±0.00 |
| CD ($P<0.05$) | 0.34 | 0.27 | 0.07 | 0.07 |

Values are mean ± SE of three independent determination

**Reducing sugars**: The range of values obtained for reducing sugars among pea varieties was 0.70 to 1.15 per cent. Reducing sugars was found to be highest in Azad variety (1.15%) followed by NDVP-08 (0.90%) and HVP-01-29 (0.79%) (Fig. 2). Pea varieties namely HVP-03-04, HVP-03-06, HVP-03-08, HVP-03-14 and VL-3 contained similar amount of reducing sugars. Non-significant difference in reducing sugar content was also noted between HVP-01-29 and Arkel varieties (Table 4.3). Earlier workers, Bishnoi (1991) and Panwar (1999) reported that reducing sugar content in pea was 0.41 to 0.57 per cent and 0.79 per cent respectively.

**Non-reducing sugars:** Non-reducing sugar content of pea varieties was found to be from 6.55 to 8.02 per cent (Fig. 2). Azad pea contained maximum amount of non-reducing sugar i.e. 8.02 per cent, followed by NDVP-08 (7.91%) and HVP-01-29 (7.80%). Reducing sugar content was similar in HVP-03-04 and HVP-03-14 varieties. There was non-significant difference in non-reducing sugar content of HVP-03-06 and HVP-03-08 varieties. Non-reducing sugar content of varieties i.e. HVP-01-29, Arkel, VL-3, Azad and NDVP-08 varied significantly from each other (Table 4.3). Bishnoi (1991) reported that non-reducing sugar content varied from 5.38 to 6.44 per cent in pea varieties. However, similar values of reducing sugar content (6.55%) were reported by Panwar (1999).

Difference in carbohydrates of green peas could be due to the extent of maturity of samples, the handling conditions prior to and during analysis and / or the genetic variations.

### 4.2.3 *In vitro* digestibility

***In vitro* protein digestibility:** *In vitro* digestibility of protein ranged from 62.10 to 68.73 per cent (Table 4.4 and Fig. 3). Protein digestibility was observed to be maximum (68.73%) in variety Azad, followed by NDVP-08 (68.04%) and HVP-01-29 (67.32%). Protein digestibility of all the pea varieties was significantly different ($P<0.05$). Similar percentage of *in vitro* protein digestibility has been reported in fresh green peas by Saharan (1991), Bishnoi (1991) and Panwar (1999).

***In vitro* starch digestibility:** *In vitro* digestibility of starch varied from 33.87 to 39.03 mg maltose/g. *In vitro* starch digestibility of pea varieties was maximum in Azad variety (39.03 mg maltose/g) followed by HVP-01-29 (38.35 mg maltose/g) and NDVP-08 (37.96 mg maltose/g). *In vitro* starch digestibility was significantly different in all the varieties except HVP-03-08 and VL-3 varieties, which showed non-significant difference in their *in vitro* starch digestibility (Fig. 3). *In vitro* starch digestibility was similar to those reported by Saharan (1991), Bishnoi (1991). On contrary to present finding lower values for *in vitro* starch digestibility has been reported by Panwar (1999).

### 4.2.4 Total Minerals

**Calcium:** Total calcium content of pea varieties ranged from 28.43 to 36.27 mg/100g (Table 4.5). Calcium content was found to be highest in Azad pea (36.27 mg/100g), followed by HVP-01-29 (35.16 mg/100g) and NDVP-08 (34.26 mg/100g). Calcium content of all the varieties differed significantly ($P<0.05$). Wide range in calcium content has been reported by several workers (Kumar and Kapoor, 1983; Wills *et al.* 1984; Lopez *et al.* 1986; Bishnoi and Khetarpaul, 1995).

**Table 4.4 : *In vitro* protein and starch digestibility (dry matter basis) of pea varieties**

| Variety | *In vitro* protein digestibility (%) | *In vitro* starch digestibility (mg maltose /g) |
|---|---|---|
| HVP-03 ï 04 | 64.48±0.04 | 36.55±0.31 |
| HVP-03 ï 06 | 63.09±0.04 | 36.65±0.04 |
| HVP-03 ï 08 | 62.86±0.02 | 34.93±0.03 |
| HVP-03 ï 14 | 63.26±0.03 | 33.87±0.03 |
| HVP-01 ï 29 | 67.32±0.03 | 38.35±0.03 |
| Arkel | 66.46±0.02 | 35.35±0.03 |
| VL-3 | 62.10±0.05 | 34.96±0.03 |
| Azad | 68.73±0.03 | 39.03±0.03 |
| NDVP-08 | 68.04±0.02 | 37.96±0.03 |
| CD (P<0.05) | 0.11 | 0.10 |

Values are mean ± SE of three independent determination

**Table 4.5: Total mineral content (mg/100g, dry matter basis) of pea varieties**

| Variety | Ca | Fe | Zn |
|---|---|---|---|
| HVP-03 ï 04 | 31.10±0.05 | 8.90±0.02 | 3.09±0.04 |
| HVP-03 ï 06 | 32.18±0.04 | 9.11±0.05 | 3.11±0.06 |
| HVP-03 ï 08 | 30.92±0.03 | 9.86±0.02 | 3.93±0.03 |
| HVP-03 ï 14 | 30.66±0.03 | 8.66±0.03 | 3.04±0.00 |
| HVP-01 ï 29 | 35.16±0.03 | 12.01±0.00 | 4.84±0.02 |
| Arkel | 29.35±0.03 | 11.90±0.00 | 3.87±0.00 |
| VL-3 | 28.43±0.03 | 10.07±0.04 | 3.92±0.02 |
| Azad | 36.27±0.03 | 13.91±0.00 | 5.46±0.02 |
| NDVP-08 | 34.26±0.03 | 12.90±0.00 | 5.05±0.02 |
| CD (P<0.05) | 0.13 | 0.08 | 0.09 |

Values are mean ± SE of three independent determination

**Iron:** Total iron content of varieties (Table 4.5) of pea varied from 8.66 to 13.91 mg/100g. Highest iron content was noticed in Azad variety (13.91 mg/100g), followed by NDVP-08 (12.90 mg/100g0 and HVP-01-29 (12.01 mg/100g). Significant differences ($P<0.05$) were observed in the total iron content of pea varieties. Panwar reported 9.06-mg/100g iron content in pea. Wide range in iron content has been observed by several workers (Kumar and Kapoor, 1983; Wills *et al.* 1984; Lopez *et al.* 1986; Bishnoi and Khetarpaul, 1995). Bishnoi (1991) reported 10.40-to 12.50-mg/100g iron content in pea varieties.

**Zinc:** Total zinc content in pea varieties ranged from 3.04 to 5.46 mg/100g. Maximum amount of zinc content (Table 4.5) was reported in Azad variety (5.46 mg/100g) followed by NDVP-08 (5.05 mg/100g) and HVP-01-29 (4.84 mg/100g) variety. Zinc content was similar in varieties i.e. HVP-03-04, HVP-03-06 and HVP-03-14. There was non-significant difference in zinc content between Arkel and VL-3 variety. Similarly, zinc content has been reported in pea varieties by Bishnoi, 1991.

### 4.2.5 Antinutrient content

**Phytic acid:** Phytic acid ranged from 587.07 to 757.76 mg/100g among pea varieties. Phytic acid content (Table 4.6) was lowest in Azad variety i.e. 587.07 mg/100g whereas HVP-01-29 and NDVP-08 contained similar amount of phytic acid, which showed non-significant difference ($P<0.05$). Phytic acid content of green peas has been found to be in range of 162.50 and 892.00 mg/100g by various workers (Manan *et al.* 1987; Sawage and Deo, 1989; Bishnoi, 1991; Das *et al.* 1993; Zdunczyk *et al.* 1997).

**Table 4.6 : Antinutrient content (mg/100g, dry matter basis) of pea varieties**

| Variety | Phytic acid | Polyphenol |
|---|---|---|
| HVP-03 ï 04 | 694.29±2.08 | 2.36±0.02 |
| HVP-03 ï 06 | 710.18±4.55 | 2.86±0.06 |
| HVP-03 ï 08 | 724.94±2.46 | 2.15±0.02 |
| HVP-03 ï 14 | 672.58±4.52 | 2.01±0.01 |
| HVP-01 ï 29 | 614.89±7.24 | 1.78±0.01 |
| Arkel | 655.99±2.62 | 2.05±0.02 |
| VL-3 | 757.76±2.31 | 2.56±0.02 |
| Azad | 587.07±8.19 | 1.66±0.02 |
| NDVP-08 | 625.53±2.73 | 1.55±0.02 |
| CD (P<0.05) | 13.79 | 0.09 |

Values are mean ± SE of three independent determination

**Polyphenol :** Polyphenol content ranged from 1020 to 1210 mg/100g in pea varieties. It was found that the varieties namely HVP-01-29, Azad and NDVP-08 contained significantly lower amount of polyphenols i.e. 1060 mg/100g, 1020 mg/100g and 1045 mg/100g respectively as compared to other varieties. Polyphenol content of all the pea varieties differed significantly ($P<0.05$) (Table 4.6). As reported by different authors polyphenol content varied from 0.77 to 2.60 mg/g (Sawage and Deo, 1989; Bishnoi, 1991; Wilskajoszka and Stasiak, 1994; Zdunczyk *et al.* 1997). Panwar (1999) reported higher value i.e. 1350 mg/100g of polyphenol content in pea. Peas contain less antinutritional substances mainly phytates, tannins, lectin and trypsin inhibitor (Huisman and Jansman, 1991).

### 4.2.6 Vitamin

**β-carotene:** ɓ-carotene content of pea varieties varied from 75.18 to 83.15 µg/100g (Table 4.7 and Fig. 4). Azad pea variety contained the maximum amount of ɓ-carotene (83.15 µg/100g) followed by HVP-01-29 (82.57 µg/100) and NDVP-08 (80.81 µg/100). ɓ-carotene content of HVP-03-06 and HVP-03-14 varieties was similar. The results are supported by the study given by Ruchika (2004) in which the reported value of ɓ-carotene in green peas was 76.10µg/100g.

**Ascorbic acid:** Ascorbic acid of pea varieties ranged from 24.63 to 31.58 mg/100g (Table 4.7). Maximum ascorbic acid content was recorded in azad variety (31.58 mg/100g) followed by HVP-01-29 (29.92 mg/100g) and NDVP-08 variety (29.80 mg/100g) (Fig. 4). Ascorbic acid content of HVP-01-29 and NDVP-08 varieties was also similar. There was non-significant

**Table 4.7 : Vitamin content (fresh basis) of pea varieties**

| Variety | B-carotene (µg/100g) | Ascorbic acid (mg/100g) |
|---|---|---|
| HVP-03 ï 04 | 75.18±0.01 | 27.23±0.03 |
| HVP-03 ï 06 | 79.92±0.02 | 25.37±0.02 |
| HVP-03 ï 08 | 78.94±0.02 | 27.05±0.03 |
| HVP-03 ï 14 | 79.39±0.01 | 27.36±0.03 |
| HVP-01 ï 29 | 82.57±0.03 | 29.92±0.02 |
| Arkel | 80.13±0.01 | 27.49±0.66 |
| VL-3 | 76.36±0.02 | 24.63±0.02 |
| Azad | 83.15±0.03 | 31.58±0.02 |
| NDVP-08 | 80.81±0.01 | 29.80±0.02 |
| CD (P<0.05) | 0.68 | 0.66 |

Values are mean ± SE of three independent determination

difference in ascorbic acid content of varieties i.e. HVP-03-04, HVP-03-08, HVP-03-14 and Arkel. Similar variations in ascorbic acid content of pea cultivars have been reported by Kaur *et al.* (1976) and Das (1979). The results of the present study are also in agreement with the results given by Favell (1997) who revealed ascorbic acid content to range from 25.60 to 30.90 mg/100g. Sheriful (2002) quoted almost similar range of 24.59 to 29.90 mg/100g of ascorbic acid in different pea cultivars.

### 4.2.7 Total chlorophyll

Total chlorophyll content in pea varieties ranged from 9.30-to 11.90 mg/100g. Highest chlorophyll content was noticed in Azad variety (11.90 mg/100g) followed by NDVP-08 variety (11.76 mg/100g) and HVP-01-29 variety (11.00 mg/100g). Total chlorophyll content differed significantly ($P<0.05$) in all pea varieties (Table 4.8). Findings are in agreement with the available literature on green pea (Kalra *et al.* 1986; Das *et al.* 1992). Das *et al.* (1993) also observed similar variations in the chlorophyll content of pea cultivars. Similar chlorophyll content (9.30-11.90mg/100g) has been reported by various workers (Sheriful, 2002; Ruchika, 2004).

**Cooking time :** Cooking time (Table 4.9) of different pea varieties ranged from 13 to 18 min. The Azad and NDVP-08 varieties recorded the minimum cooking time i.e. 14 minutes while the variety HVP-01-29 had the cooking time i.e.15 minutes. Cooking time of all the pea varieties differed significantly ($P<0.05$).

**Table 4.8 : Total chlorophyll content (mg/100g, fresh matter basis) of pea varieties**

| Variety | Chlorophyll |
|---|---|
| HVP-03 ï 04 | 9.80±0.00 |
| HVP-03 ï 06 | 10.11±0.00 |
| HVP-03 ï 08 | 10.30±0.00 |
| HVP-03 ï 14 | 10.75±0.00 |
| HVP-01 ï 29 | 11.00±0.00 |
| Arkel | 10.50±0.00 |
| VL-3 | 9.30±0.00 |
| Azad | 11.90±0.00 |
| NDVP-08 | 11.76±0.00 |
| CD (P<0.05) | 0.01 |

Values are mean ± SE of three independent determination

**Table 4.9 : Cooking time of pea (fresh matter basis) varieties**

| Variety | Cooking time (min) |
|---|---|
| HVP-03-04 | 17±0.23 |
| HVP-03-06 | 16±0.21 |
| HVP-03-08 | 18±0.14 |
| HVP-03-14 | 16±0.51 |
| HVP-01-29 | 15±0.22 |
| Arkel | 17±0.15 |
| VL-3 | 13±0.15 |
| Azad | 14±0.41 |
| NDVP-08 | 14±0.07 |
| CD (<0.05) | 0.40 |

Values are mean ± SE of three independent determination

## 4.3 ORGANOLEPTIC EVALUATION

Dry and curry vegetables were prepared to test the acceptability of selected pea varieties. Organoleptic evaluation was got done by a panel of ten judges using 9-point Hedonic Rating Scale.

**Dry vegetable:** Mean scores of sensory evaluation of dry vegetable prepared from pea varieties are presented in Table 4.10. Mean scores of appearance and texture of dry vegetable prepared from all pea varieties were similar and showed non-significant differences. Mean scores of colour, flavour, taste and overall acceptability of dry vegetable prepared from varieties i.e. HVP-01-29, Azad and NDVP-08 were significantly ($P<0.05$) higher than other varieties. Mean scores of colour, appearance, flavour, texture, taste and overall acceptability indicated that the dry vegetable prepared from different varieties was liked moderately.

**Curry vegetable:** Mean score of sensory evaluation of curry vegetable prepared from pea varieties are presented in Table 4.11. Mean scores of appearance and flavour of curry vegetable prepared from pea varieties were similar and showed non-significant differences. Whereas, mean scores of colour, texture, taste and overall acceptability of curry vegetable prepared from varieties i.e. HVP-01-29, Azad and NDVP-08 were significantly ($P<0.05$) higher than other varieties. Mean scores of colour, appearance, flavour, texture, taste and overall acceptability indicated that the dry vegetable prepared from different varieties was liked moderately.

**Table 4.10 : Mean scores of sensory evaluation of dry vegetable prepared from pea**

| Variety | Colour | Appearance | Flavour | Texture | Taste | Overall acceptability |
|---|---|---|---|---|---|---|
| HVP-03 ï 04 | 7.10±0.15 | 7.20±0.18 | 7.10±0.17 | 7.20±0.18 | 7.30±0.15 | 7.18±0.17 |
| HVP-03 ï 06 | 7.30±0.16 | 7.20±0.33 | 7.20±0.21 | 7.30±0.33 | 7.30±0.21 | 7.26±0.25 |
| HVP-03 ï 08 | 7.20±0.13 | 7.20±0.16 | 7.30±0.16 | 7.30±0.43 | 7.20±0.16 | 7.24±0.21 |
| HVP-03 ï 14 | 7.10±0.11 | 7.20±0.19 | 7.30±0.30 | 7.10±0.31 | 7.10±0.13 | 7.16±0.13 |
| HVP-01 ï 29 | 7.90±0.26 | 7.30±0.23 | 7.60±0.23 | 7.30±0.27 | 7.90±0.23 | 7.60±0.24 |
| Arkel | 7.30±0.12 | 7.20±0.20 | 7.20±0.11 | 7.10±0.11 | 7.30±0.02 | 7.22±0.11 |
| VL-3 | 7.20±0.21 | 7.30±0.21 | 7.20±0.16 | 7.10±0.35 | 7.30±0.34 | 7.22±0.25 |
| Azad | 7.80±0.16 | 7.50±0.16 | 7.90±0.00 | 7.40±0.16 | 7.90±0.00 | 7.70±0.16 |
| NDVP-08 | 7.80±0.13 | 7.40±0.12 | 7.70±0.25 | 7.30±0.25 | 7.80±0.29 | 7.60±0.21 |
| CD (P<0.05) | 0.30 | NS | 0.35 | NS | 0.40 | 0.38 |

Values are mean ± SE of ten replicates

**Table 4.11: Mean scores of sensory evaluation of curry vegetable prepared from pea varieties**

| Variety | Colour | Appearance | Flavour | Texture | Taste | Overall acceptability |
|---|---|---|---|---|---|---|
| HVP-03 ï 04 | 7.20±0.21 | 7.10±0.40 | 7.30±0.22 | 7.10±0.40 | 7.20±0.22 | 7.18±0.25 |
| HVP-03 ï 06 | 7.30±0.22 | 7.20±0.22 | 7.20±0.36 | 7.10±0.21 | 7.20±0.21 | 7.20±0.24 |
| HVP-03 ï 08 | 7.10±0.23 | 7.30±0.26 | 7.30±0.22 | 7.10±0.22 | 7.20±0.22 | 7.20±0.15 |
| HVP-03 ï 14 | 7.30±0.16 | 7.20±0.33 | 7.10±0.21 | 7.10±0.21 | 7.30±0.33 | 7.52±0.25 |
| HVP-01 ï 29 | 7.70±0.18 | 7.30±0.18 | 7.20±0.18 | 7.70±0.18 | 7.70±0.18 | 7.24±0.18 |
| Arkel | 7.30±0.18 | 7.30±0.22 | 7.20±0.18 | 7.10±0.11 | 7.30±0.15 | 7.20±0.18 |
| VL-3 | 7.20±0.20 | 7.30±0.21 | 7.10±0.22 | 7.30±0.21 | 7.10±0.22 | 7.40±0.21 |
| Azad | 7.80±0.24 | 7.40±0.16 | 7.40±0.24 | 7.90±0.24 | 7.90±0.10 | 7.68±0.14 |
| NDVP-08 | 7.80±0.16 | 7.30±0.21 | 7.30±0.25 | 7.70±0.20 | 7.60±0.20 | 7.54±0.24 |
| CD (P<0.05) | 0.35 | NS | NS | 0.38 | 0.31 | 0.30 |

Values are mean ± SE of ten replicates

## 4.4 PROCESSING OF PEA FOR EXTENDING SHELF LIFE

Based on physical, nutritional parameters and acceptability trial, three pea varieties i.e. HVP-01-29, Azad and NDVP-08 were selected and subjected to processing methods namely dehydration (sun drying and oven drying) and freezing. Dehydrated peas were stored in polypacks at room temperature and frozen peas were kept in deep freezer for three months. These were evaluated for following parameters at 0, 1, 2 and 3 months.

**Cooking quality** :

Frozen and dried peas were analyzed for various cooking quality parameters and results of the same are presented below:

**Soaking time:** Dried peas were soaked in distilled water [pea: water; 1:4 (w/v)] for 12 hours at $37^0$C.

**Swelling capacity :** Swelling capacity in sun dried peas ranged from 0.05 to 0.13 ml/seed in various varieties throughout the storage period. There was slight decrease in swelling capacity during 0, $30^{th}$, $60^{th}$ and $90^{th}$ day of storage, which varied from 7.69 to 50.00 per cent (Table 4.12). However, this decline in swelling capacity was non-significant. This indicated that swelling capacity remained almost same till 90 days of storage. Non-significant difference in the swelling capacity of various sun dried varieties was also observed on 0 day. This indicated that the swelling capacity of sun dried peas of various varieties was same at the start of storage time. During storage also the varietal difference remained non significant.

**Table 4.12 : Effect of storage on swelling capacity (ml/seed) of dried pea varieties**

| Variety | Storage period (days) | | | | |
|---|---|---|---|---|---|
| **Sun drying** | **0** | **30** | **60** | **90** | **CD (<0.05)** |
| HVP-01-29 | 0.10+ 0.03 | 0.08+0.01 (20.00) | 0.06+0.02 (40.00) | 0.05+0.02 (50.00) | NS |
| Azad | 0.11+0.01 | 0.10+0.02 (9.00) | 0.09+0.01 (18.18) | 0.07+0.02 (36.36) | NS |
| NDVP-08 | 0.13+0.02 | 0.12+. 01 (7.69) | 0.11+0.01 (15.38) | 0.09+0.01 (30.76) | NS |
| **CD (<0.05)** | NS | NS | NS | NS | |
| **Oven drying** | | | | | |
| HVP-01-29 | 0.08+0.02 | 0.06+. 02 (25.00) | 0.05+0.01 (37.50) | 0.04+0.02 (50.00) | NS |
| Azad | 0.09+0.01 | 0.08+. 03 (11.11) | 0.07+0.02 (22.22) | 0.05+0.01 (44.44) | NS |
| NDVP-08 | 0.10+0.02 | 0.09+. 02 (10.00) | 0.07+0.01 (30.00) | 0.06+0.03 (40.00) | NS |
| **CD (<0.05)** | NS | NS | NS | NS | |
| **CD (<0.05):** | | | | | |
| HVP-01-29 | NS | NS | NS | NS | |
| Azad | NS | NS | NS | NS | |
| NDVP-08 | NS | NS | NS | NS | |

Values are mean $\pm$ SE three independent determination.

Figures in parenthesis indicate percent change compared to zero day

Swelling capacity of oven dried peas ranged from 0.04 to 0.10 ml/100seed in various varieties during the storage period. There was decline in swelling capacity during 0, 30$^{th}$, 60$^{th}$, and 90$^{th}$ day of storage, which ranged from 10.00 to 50.00 per cent. However this decline in swelling capacity was non-significant. This indicated that swelling capacity remained almost same till 90 days of storage. Non-significant difference in swelling capacity of various oven dried varieties was also observed on 0 day. This indicated that the swelling capacity of sun dried peas of various varieties was same at the start of storage time. During storage also the varietal difference remained non-significant.

Non-significant difference was observed in the swelling capacity of variety HVP-01-29 during all the treatments and storage. Similarly, non-significant differences were observed for other two varieties i.e. Azad and NDVP-08 for treatments and storage.

**Hydration capacity:** Hydration capacity (Table 4.13) in sun dried peas ranged from 0.14 to 0.32 g/seed in various varieties throughout the storage period. There was decline i.e. 6.25 to 26.30 per cent in hydration capacity during the 0, 30$^{th}$, 60$^{th}$ and 90$^{th}$ day storage. However the decline was non-significant. This indicated that hydration capacity of sun dried peas remained almost same till 90 days of storage. Significant difference in the hydration capacity of various sun dried varieties was observed on 0 day. Hydration capacity of NDVP-08 was significantly higher followed by Azad and lowest hydration capacity was observed in HVP-01-29.The trend remained same at various intervals of storage.

**Table 4. 13: Effect of storage on hydration capacity (g/seed) of dried pea varieties**

| Variety | Storage period (days) | | | | |
|---|---|---|---|---|---|
| **Sun drying** | **0** | **30** | **60** | **90** | **CD (<0.05)** |
| HVP-01-29 | 0.19. +0. 01 | 0.17+0.02 (10.52) | 0.15+0. 01 (21.00) | 0.14+0. 01 (26.30) | NS |
| Azad | 0.30 +0. 01 | 0.28+0. 03 (6.66) | 0.26+0. 04 (13.30) | 0.25+0. 02 (16.60) | NS |
| NDVP-08 | 0.32+0. 01 | 0.30+0. 02 (6.25) | 0.26+0. 01 (18.75) | 0.26+0. 03 (18.75) | NS |
| **CD (<0.05)** | 0.06 | 0.04 | 0.05 | 0.03 | |
| **Oven drying** | | | | | |
| HVP-01-29 | 0.22+0. 01 | 0.21+0. 01 (4.54) | 0.19+0. 01 (13.60) | 0.17+0. 02 (22.70) | NS |
| Azad | 0.31+0. 02 | 0.30+0. 03 (3.22) | 0.29+0. 02 (6.45) | 0.27+0. 02 (12.90) | NS |
| NDVP-08 | 0.34+0. 01 | 0.32+0. 02 (5.88) | 0.30+0. 01 (11.76) | 0.29+0. 01 (14.70) | NS |
| **CD (<0.05)** | 0.05 | 0.06 | 0.03 | 0.05 | |
| **CD (<0.05) :** | | | | | |
| HVP-01-29 | NS | NS | NS | NS | |
| Azad | NS | NS | NS | NS | |
| NDVP-08 | NS | NS | NS | NS | |

Values are mean $\pm$ SE three independent determination

Figures in parenthesis indicate percent change compared to zero day

Hydration capacity in oven dried peas varied from 0.17 to 0.34 g/seed in various varieties throughout the storage period. There was decline of 3.22 to 22.78 per cent in by hydration capacity during 0, 30$^{th}$, 60$^{th}$ and 90$^{th}$ day of storage. The decline was non-significant. This indicated that hydration capacity of oven dried peas remained almost same till 90 days of storage Significant difference in the hydration capacity of various oven dried varieties was estimated on 0 day. Hydration capacity of NDVP-08 was significantly higher followed by Azad and lowest hydration capacity was observed in HVP-01-29.The trend remained same at various intervals of storage.

Non-significant difference was observed in the hydration capacity of variety HVP-01-29 during all the treatments and storage. Similarly, non-significant differences were observed for other two varieties i.e. Azad and NDVP-08 for all treatments and storage.

**Cooking time:** Cooking time in frozen peas varied from 08 to 17 minutes in various varieties throughout the storage period (Table 4.14). There was increase i.e. 10 to 30.76 per cent in cooking time during 0, 30$^{th}$, 60$^{th}$, and 90$^{th}$ day of storage. The increase was statistically non-significant. This indicated that there was no change in cooking time of frozen peas upto the end of storage period. Significant difference in cooking time of various frozen varieties was estimated on 0 day. Cooking time of HVP-01-29 was significantly higher followed by NDVP-08 and lowest cooking time was observed in Azad.The trend remained similar at various intervals of storage period.

**Table 4.14 : Effect of storage on cooking time (min) of frozen and dried pea varieties**

| Variety | Storage period (days) | | | | |
|---|---|---|---|---|---|
| **Freezing** | **0** | **30** | **60** | **90** | **CD (<0.05)** |
| HVP-01-29 | 13±0.08 | 15±0.18 (15.38) | 16±0.17 (23.07) | 17±0.14 (30.76) | NS |
| Azad | 10±0.05 | 11±0.33 (10.00) | 12±0.36 (20.00) | 12±0.36 (20.00) | NS |
| NDVP-08 | 08±0.11 | 09±0.08 (12.50) | 10±0.04 (25.00) | 11±0.30 (37.50) | NS |
| **CD (<0.05)** | 1.13 | 1.15 | 1.14 | 1.15 | |
| **Sun drying** | | | | | |
| HVP-01-29 | 35±0.10 | 37±0.05 (5.71) | 39±0.06 (11.42) | 40±0.10 (14.28) | NS |
| Azad | 33±0.10 | 34±0.00 (3.03) | 35±0.10 (6.06) | 36±0.04 (9.09) | NS |
| NDVP-08 | 30±0.04 | 31±0.04 (3.33) | 32±0.02 (6.66) | 34±0.05 (13.33) | NS |
| **CD (<0.05)** | 1.11 | 1.10 | 1.15 | 1.12 | |
| **Oven drying** | | | | | |
| HVP-01-29 | 39±0.07 | 42±0.01 (7.69) | 43±0.05 (10.25) | 44±0.05 (12.82) | NS |
| Azad | 36±0.04 | 37±0.05 (2.77) | 38±0.01 (5.55) | 40±0.10 (11.11) | NS |
| NDVP-08 | 34±0.06 | 36±0.04 (5.88) | 37±0.04 (8.82) | 38±0.01 (11.76) | NS |
| **CD (<0.05)** | 1.16 | 1.13 | 1.17 | 1.13 | |
| **CD (<0.05) :** | | | | | |
| HVP-01-29 | 1.03 | 1.16 | 1.13 | 1.15 | |
| Azad | 1.12 | 1.15 | 1.16 | 1.14 | |
| NDVP-08 | 1.11 | 1.14 | 1.12 | 1.15 | |

Values are mean ± SE three independent determination.

Figures in parenthesis indicate percent change compared to zero day

Cooking time in sun dried peas ranged from 30 to 40 minutes in various varieties during the storage period. There was non-significant increase of 3.03 to 14.28 percent in cooking time during the 0, $30^{th}$, $60^{th}$ ad $90^{th}$ day of storage. This indicated that there was no change in cooking time of sun dried peas upto the end of storage period. Significant difference in cooking time of various sun dried varieties was observed on 0 day. Cooking time of HVP-01-29 was significantly higher followed by NDVP-08 and lowest cooking time was observed in Azad.The trend remained similar at various intervals of storage period.

Cooking time in oven dried peas ranged from 34 to 44 minutes in various varieties throughout the storage period. Increase of 2.77 to 12.82 per cent was noticed in cooking time during 0, $30^{th}$, $60^{th}$ and $90^{th}$ day of storage. However, the increase was statistically non-significant. This showed that there was no change in cooking time of oven dried peas during storage. Statistically significant difference in various oven dried varieties was observed on 0 day. Cooking time of HVP-01-29 was significantly higher followed by NDVP-08 and lowest cooking time was observed in Azad.The trend remained similar at various intervals of storage period. Das et al (1993) quoted value of cooking time from 12-31 min in various dehydrated varieties. It is known that cooking time of peas and different kind of beans increases on storage. Bongirwar and Sreenivasan (1976) used reported that <12% moisture were found to be very good after storage up to one year, beyond which, moisture absorption by the peas to a certain extent did occur resulting in increase of cooking time.

Difference was observed in the cooking time of variety HVP-01-29 during all the treatments and storage, which was statistically significant. Similar, non-significant differences were observed for other two varieties i.e. Azad and NDVP-08 for all treatments and storage. Sharma (1989) reported that the legumes having the higher hydration and swelling coefficients require less cooking time and hence, are preferred by the consumers and processors too. As Azad, HVP-01-29 and NDVP-08 varieties have the maximum hydration and swelling capacity thereby they required less cooking time, which will be useful for saving full energy.

## 4.6 ORGANOLEPTIC EVALUATION OF VEGETABLE DURING STORAGE

Dry and curry vegetables were prepared from frozen and dried peas. Organoleptic evaluation was got done by a panel of ten judges using 9-point Hedonic Rating Scale. The mean scores of dry and curry vegetable in terms of colour, appearance, flower, texture, taste and overall acceptability is discussed as under:

### Dry vegetable

**Colour:** Mean scores of colour of dry vegetable prepared from frozen peas indicated that colour was almost similar in Azad and NDVP-08 variety on 0 day of storage as well as on $30^{th}$, $60^{th}$ and $90^{th}$ day of storage and was in liked moderately category. Significantly lower scores for colour were observed in HVP-01-29 variety on 0, $30^{th}$, $60^{th}$ and 90 day of storage. But still they were in liked moderately category (Table 4.15). Non-significant differences in mean scores of colour of dry vegetable prepared by frozen peas were observed during the total period of storage. This indicated that there was no change in the colour of frozen peas during storage.

**Table 4.15: Effect of storage on mean scores of colour of dry vegetable prepared from frozen and dried pea varieties**

| Variety | Storage period (days) | | | | |
|---|---|---|---|---|---|
| **Freezing** | **0** | **30** | **60** | **90** | **CD (<0.05)** |
| HVP-01-29 | 7.40±0.16 | 7.30±0.16 | 7.30±0.00 | 7.20±0.13 | NS |
| Azad | 7.90±0.00 | 7.80±0.00 | 7.70±0.15 | 7.70±0.13 | NS |
| NDVP-08 | 7.80±0.13 | 7.70±0.15 | 7.70±0.13 | 7.60±0.15 | NS |
| **CD (<0.05)** | 0.35 | 0.34 | 0.36 | 0.38 | |
| **Sun drying** | | | | | |
| HVP-01-29 | 7.40±0.16 | 7.30±0.15 | 7.30±0.15 | 7.20±0.13 | NS |
| Azad | 7.80±0.13 | 7.80±0.13 | 7.70±0.15 | 7.70±0.15 | NS |
| NDVP-08 | 7.70±0.15 | 7.70±0.15 | 7.70±0.15 | 7.70±0.15 | NS |
| **CD (<0.05)** | 0.29 | 0.42 | 0.36 | 0.42 | |
| **Oven drying** | | | | | |
| HVP-01-29 | 7.40±0.16 | 7.40±0.16 | 7.40±0.16 | 7.30±0.15 | NS |
| Azad | 7.80±0.13 | 7.80±0.13 | 7.70±0.15 | 7.70±0.13 | NS |
| NDVP-08 | 7.70±0.15 | 7.70±0.13 | 7.70±0.13 | 7.60±0.10 | NS |
| **CD (<0.05)** | NS | NS | NS | NS | |
| **CD(<0.05)** : | | | | | |
| HVP-01-29 | NS | NS | NS | NS | |
| Azad | NS | NS | NS | NS | |
| NDVP-08 | NS | NS | NS | NS | |

Values are mean ± SE of ten replicates

Mean scores of colour of dry vegetable prepared from sun dried peas indicated that colour was almost similar in Azad and NDVP-08 variety on 0 day of storage as well as on $30^{th}$, $60^{th}$ and $90^{th}$ day of storage and was in liked moderately category. Significantly lower scores for colour were observed in HVP-01-29 variety on 0, $30^{th}$, $60^{th}$ and $90^{th}$ day of storage. But still they were in liked moderately category. Non-significant differences in mean scores of colour of dry vegetable prepared from sun-dried peas were observed during the total period of storage. This indicated that there was no change in the colour of sun-dried peas during storage.

Mean scores of colour of dry vegetable prepared from oven dried peas indicated that colour was almost similar in dry vegetable prepared from the varieties i.e. HVP-01-29, Azad and NDVP-08 on 0, $30^{th}$, $60^{th}$ and $90^{th}$ day of storage and they were liked moderately. Non significant differences in mean score of colour of dry vegetable prepared by oven dried peas were observed during the total period of storage this indicated that there was no change in the colour of oven dried peas during storage.

Non-significant difference was observed in the mean scores of colour of dry vegetable prepared from variety HVP-01-29 during all the three treatments i.e. freezing, sun drying and oven drying and also during the period of storage. Similarly non-significant differences were observed for other two varieties i.e. Azad and NDVP-08 for treatment and storage period.

**Appearance:** Mean scores of appearance of dry vegetable prepared from frozen pea indicated that appearance (Table 4.16) was almost similar in Azad and NDVP-08 variety on 0 day of storage as well as on $30^{th}$, $60^{th}$ and $90^{th}$ day of storage and was in liked moderately category. Significantly lower scores for appearance were observed in HVP-01-29 variety on 0, $30^{th}$, $60^{th}$ and $90^{th}$ day of storage. But still they were in liked moderately category. Non-significant differences in mean scores of appearance of dry vegetable prepared by frozen pea were observed during the total period of storage. This indicated that there was no change in the appearance of frozen peas during storage.

Mean scores of appearance of dry vegetable prepared from sun dried peas indicated that appearance was almost similar in Azad and NDVP-08 variety on 0 day of storage as well as on $30^{th}$, $60^{th}$, and $90^{th}$ day of storage and was in liked moderately category. Significantly lower scores for appearance were observed in HVP-01-29 variety on 0, $30^{th}$, $60^{th}$ and $90^{th}$ day of storage. But still they were in liked moderately category. Non-significant differences in mean scores of appearance of dry vegetable prepared from sun-dried peas was observed during the total storage. This indicated that there was no change in the appearance of sun dried peas during storage.

Mean scores of appearance of dry vegetable prepared from oven dried peas indicated that appearance was almost similar in Azad and NDVP-08 variety on 0, $30^{th}$, $60^{th}$ and $90^{th}$ day of storage and they were liked moderately. Significantly lower scores for appearance were observed in HVP-01-29 variety on 0, $30^{th}$, $60^{th}$ and $90^{th}$ day of storage.

**Table 4.16 : Effect of storage on mean scores of appearance of dry vegetable prepared from frozen and dried pea varieties**

| Variety | Storage period (days) | | | | |
|---|---|---|---|---|---|
| **Freezing** | **0** | **30** | **60** | **90** | **CD (<0.05)** |
| HVP-01-29 | 7.20±0.13 | 7.20±0.16 | 7.10±0.16 | 7.10±0.15 | NS |
| Azad | 7.90±0.00 | 7.80±0.13 | 7.80±0.13 | 7.90±0.10 | NS |
| NDVP-08 | 7.70±0.13 | 7.70±0.15 | 7.70±0.13 | 7.60±0.15 | NS |
| **CD (<0.05)** | 0.41 | 0.42 | 0.38 | 0.42 | |
| **Sun drying** | | | | | |
| HVP-01-29 | 7.20±0.13 | 7.20±0.13 | 7.00±0.00 | 7.00±0.00 | NS |
| Azad | 7.80±0.13 | 7.80±0.13 | 7.70±0.15 | 7.70±0.15 | NS |
| NDVP-08 | 7.70±0.15 | 7.70±0.15 | 7.50±0.15 | 7.50±0.15 | NS |
| **CD (<0.05)** | 0.40 | 0.40 | 0.37 | 0.37 | |
| **Oven drying** | | | | | |
| HVP-01-29 | 7.20±0.13 | 7.20±0.15 | 7.20±0.15 | 7.10±0.15 | NS |
| Azad | 7.80±0.13 | 7.80±0.13 | 7.80±0.13 | 7.80±0.13 | NS |
| NDVP-08 | 7.70±0.15 | 7.70±0.13 | 7.70±0.13 | 7.60±0.10 | NS |
| **CD (<0.05)** | 0.40 | 0.40 | 0.42 | 0.42 | |
| **CD (<0.05) :** | | | | | |
| HVP-01-29 | NS | NS | NS | NS | |
| Azad | NS | NS | **NS** | NS | |
| NDVP-08 | NS | NS | NS | NS | |

Values are mean ± SE of ten replicates

Non-significant differences in mean scores of appearance of dry vegetable prepared by oven dried peas were observed during the total period of storage. This indicated that there was no change in the appearance of oven dried peas during storage.

Non-significant difference was observed in the mean scores of appearance of dry vegetable prepared from variety HVP-01-29 during all the three treatments i.e. freezing, sun drying and oven drying and also during the period of storage. Similarly non-significant differences were observed for other two varieties i.e. Azad and NDVP-08 for treatments and storage period.

**Flavour:** Mean scores of flavour of dry vegetable prepared from frozen pea indicated that flavour was almost similar in HVP-01-29 and NDVP-08 variety on 0 day of storage as well as on $30^{th}$, $60^{th}$ and $90^{th}$ day of storage and was in liked moderately category (Table 4.17). Significantly higher scores for flavour were observed in Azad variety on 0, $30^{th}$, $60^{th}$ and $90^{th}$ day of storage. But they were also in liked moderately category. Non-significant differences in mean scores of flavour of dry vegetable prepared by frozen peas were observed during the total period of storage. This indicated that there was no change in the flavour of frozen peas during storage.

Mean scores of flavour of dry vegetable prepared from sun dried peas indicated that flavour was almost similar in HVP-01-29 and NDVP-08 variety on 0 day of storage as well as on $30^{th}$, $60^{th}$ and 90 day of storage and was in liked moderately category. Non-significant differences in mean scores of flavour of dry vegetable prepared from sun-dried peas were observed during the total period of storage. This indicated that there was no change in the flavour of sun-dried peas during storage.

**Table 4.17 : Effect of storage on mean scores of flavour of dry vegetable prepared from frozen and dried pea varieties**

| Variety | Storage period (days) | | | | |
|---|---|---|---|---|---|
| **Freezing** | **0** | **30** | **60** | **90** | **CD (<0.05)** |
| HVP-01-29 | 7.20±0.13 | 7.20±0.15 | 7.20±0.15 | 7.10±0.15 | NS |
| Azad | 7.90±0.00 | 7.80±0.13 | 7.80±0.13 | 7.70±0.10 | NS |
| NDVP-08 | 7.20±0.13 | 7.20±0.15 | 7.20±0.13 | 7.10±0.15 | NS |
| **CD (<0.05)** | 0.31 | 0.40 | 0.42 | 0.39 | |
| **Sun drying** | | | | | |
| HVP-01-29 | 7.20±0.13 | 7.00±0.00 | 7.00±0.00 | 7.00±0.00 | NS |
| Azad | 7.90±0.00 | 7.90±0.10 | 7.90±0.10 | 7.80±0.10 | NS |
| NDVP-08 | 7.20±0.15 | 7.00±0.15 | 7.00±0.15 | 7.00±0.15 | NS |
| **CD (<0.05)** | 0.31 | 0.16 | 0.16 | 0.16 | |
| **Oven drying** | | | | | |
| HVP-01-29 | 7.30±0.15 | 7.30±0.16 | 7.30±0.15 | 7.20±0.16 | NS |
| Azad | 7.90±0.00 | 7.80±0.13 | 7.70±0.15 | 7.70±0.15 | NS |
| NDVP-08 | 7.70±0.15 | 7.70±0.13 | 7.60±0.13 | 7.50±0.10 | NS |
| **CD (<0.05)** | 0.31 | 0.34 | 0.35 | 0.33 | |
| **CD (<0.05) :** | | | | | |
| HVP-01-29 | NS | NS | NS | NS | |
| Azad | NS | NS | NS | NS | |
| NDVP-08 | 0.35 | 0.33 | 0.36 | 0.36 | |

Values are mean ± SE of ten replicates

Mean scores of flavour of dry vegetable prepared from oven dried peas indicated that flavour was almost similar in dry vegetable prepared from the varieties Azad and NDVP-08 on 0, 30$^{th}$, 60$^{th}$ ad 90$^{th}$ day of storage and they were liked moderately. Non-significant differences in mean scores of flavour of dry vegetable prepared by oven-dried peas were observed during the storage period.

Non-significant difference was observed in the mean scores of flavour of dry vegetable prepared from varieties i.e. HVP-01-29 and Azad during all the three treatments i.e. freezing sun drying and oven drying and also during the period of storage. While significant difference was observed in mean scores of flavour of dry vegetable prepared from variety. NDVP-08 during all the treatments i.e. freezing, sun drying and oven drying and also during the period of storage.

**Texture:** Mean scores of texture (Table 4.18) of dry vegetable prepared from frozen peas showed that texture was almost similar in dry vegetables prepared from the i.e. varieties i.e.HVP-01-29, Azad and NDVP-08 on 0, 30$^{th}$, 60$^{th}$, and 90$^{th}$ day of storage and they were liked moderately. Non-significant differences in mean scores of textures of dry vegetable prepared by frozen peas were observed during the total period of storage. This indicated that there was no change in the colour of frozen peas during storage.

Mean scores of texture of dry vegetable prepared from sun dried peas indicated that colour was almost similar in HVP-01-29 and Azad variety on 0 day of storage as well as on 30$^{th}$, 60$^{th}$ and 90$^{th}$ day of storage and were in liked moderately category. Significantly lower scores for

**Table 4.18 : Effect of storage on mean scores of texture of dry vegetable prepared from frozen and dried pea varieties**

| Variety | Storage period (days) | | | | |
|---|---|---|---|---|---|
| **Freezing** | **0** | **30** | **60** | **90** | **CD (<0.05)** |
| HVP-01-29 | 7.50±0.16 | 7.50±0.15 | 7.50±0.15 | 7.40±0.16 | NS |
| Azad | 7.80±0.13 | 7.60±0.16 | 7.40±0.16 | 7.40±0.16 | NS |
| NDVP-08 | 7.40±0.13 | 7.40±0.16 | 7.30±0.16 | 7.20±0.16 | NS |
| **CD (<0.05)** | NS | NS | NS | NS | |
| **Sun drying** | | | | | |
| HVP-01-29 | 7.50±0.16 | 7.50±0.16 | 7.40±0.16 | 7.40±0.16 | NS |
| Azad | 7.80±0.13 | 7.70±0.15 | 7.70±0.15 | 7.50±0.16 | NS |
| NDVP-08 | 7.20±0.13 | 7.20±0.13 | 7.00±0.00 | 7.00±0.00 | NS |
| **CD (<0.05)** | 0.42 | 0.43 | 0.38 | 0.39 | |
| **Oven drying** | | | | | |
| HVP-01-29 | 7.50±0.16 | 7.40±0.16 | 7.30±0.15 | 7.30±0.16 | NS |
| Azad | 7.80±0.13 | 7.60±0.16 | 7.40±0.16 | 7.40±0.16 | NS |
| NDVP-08 | 7.80±0.13 | 7.70±0.15 | 7.60±0.16 | 7.60±0.00 | NS |
| **CD (<0.05)** | NS | NS | NS | NS | |
| **CD (<0.05) :** | | | | | |
| HVP-01-29 | NS | NS | NS | NS | |
| Azad | NS | NS | NS | NS | |
| NDVP-08 | 0.40 | 0.43 | 0.38 | 0.27 | |

Values are mean ± SE of ten replicates

texture were observed in NDVP-08 variety on 0, 30$^{th}$, 60$^{th}$ and 90$^{th}$ day of storage. But still they were in liked moderately category. Non-significant differences in mean scores of texture of dry vegetable prepared from sun-dried peas during storage. This indicated that there was no change in the texture of sun-dried peas during storage.

Mean scores of texture of dry vegetable prepared from oven dried peas indicated that texture was almost similar in dry vegetable prepared from the varieties i.e. HVP-01-29, Azad and NDVP-08 on 0, 30$^{th}$, 60$^{th}$ and 90$^{th}$ day of storage and they were liked moderately. Non-significant differences in mean scores of texture of dry vegetable prepared by oven-dried peas were observed during the total period of storage. This indicated that there was no change in the texture of oven-dried peas during storage.

Non-significant differences were observed in mean scores of texture of dry vegetable prepared from variety i.e. HVP-01-29 and Azad during all the three treatments i.e. freezing, sun drying and oven drying and also during the period of storage. Whereas, significant ($P<0.05$) difference was observed in mean scores of texture of dry vegetable prepared from variety NDVP-08 during all the treatments and period of storage.

**Taste:** mean scores of taste of dry vegetable prepared from frozen peas showed that taste was almost similar in dry vegetable prepared from the varieties i.e. HVP-01-29, Azad and NDVP-08 on 0, 30$^{th}$, 60$^{th}$ and 90$^{th}$ day of storage and they were liked moderately. Non-significant difference in mean scores of taste of dry vegetable prepared by frozen peas were observed during the total period of storage. This indicated that there was no change in taste of frozen peas during storage (Table 4.19).

**Table 4.19 : Effect of storage on mean scores of taste of dry vegetable prepared from frozen and dried pea varieties**

| Variety | Storage period (days) | | | | |
|---|---|---|---|---|---|
| **Freezing** | **0** | **30** | **60** | **90** | **CD (<0.05)** |
| HVP-01-29 | 7.70±0.15 | 7.60±0.16 | 7.60±0.15 | 7.50±0.00 | NS |
| Azad | 7.90±0.00 | 7.60±0.16 | 7.60±0.16 | 7.50±0.16 | NS |
| NDVP-08 | 7.60±0.16 | 7.60±0.16 | 7.60±0.16 | 7.50±0.15 | NS |
| **CD (<0.05)** | NS | NS | NS | NS | |
| **Sun drying** | | | | | |
| HVP-01-29 | 7.70±0.15 | 7.60±0.16 | 7.50±0.16 | 7.40±0.16 | NS |
| Azad | 7.80±0.13 | 7.70±0.15 | 7.70±0.15 | 7.60±0.16 | NS |
| NDVP-08 | 7.60±0.16 | 7.60±0.16 | 7.60±0.16 | 7.40±0.16 | NS |
| **CD (<0.05)** | NS | NS | NS | NS | |
| **Oven drying** | | | | | |
| HVP-01-29 | 7.60±0.16 | 7.50±0.16 | 7.50±0.16 | 7.40±0.16 | NS |
| Azad | 7.90±0.00 | 7.90±0.10 | 7.80±0.10 | 7.80±01.0 | NS |
| NDVP-08 | 7.60±0.16 | 7.60±0.13 | 7.50±0.15 | 7.50±0.15 | NS |
| **CD (<0.05)** | NS | NS | NS | NS | |
| **CD (<0.05) :** | | | | | |
| HVP-01-29 | NS | NS | NS | NS | |
| Azad | NS | NS | NS | NS | |
| NDVP-08 | NS | NS | NS | NS | |

Values are mean ± SE of ten replicates

Mean scores of taste of dry vegetable prepared from sun dried peas showed that taste was almost similar in dry vegetable prepared from the varieties i.e. HVP-01-29, Azad and NDVP-08 on 0, 30$^{th}$, 60$^{th}$ and 90$^{th}$ day of storage and they were liked moderately. Non-significant differences in mean scores of taste of dry vegetable prepared by sun-dried peas were observed during the total period of storage. This indicated that there was no change in the taste of sun-dried peas during storage.

Mean scores of taste of dry vegetable prepared from oven dried peas indicated that taste was almost similar in dry vegetable prepared from the varieties i.e. HVP-01-29, Azad and NDVP-08 on 0, 30$^{th}$, 60$^{th}$ and 90$^{th}$ day of storage and they were liked moderately. Non-significant differences in mean scores of taste of dry vegetable prepared by oven-dried peas were observed during the total period storage. This showed that the taste of oven dried peas remained unchanged during storage.

Non-significant difference was observed in mean scores of taste of dry vegetable prepared from variety HVP-01-29 during all the three treatments i.e. freezing, sun drying and oven drying and also during the period of storage. Similarly, non-significant ($P<0.05$) differences in mean scores of taste of dry vegetable prepared from other two varieties i.e. Azad and NDVP-08 were observed for treatment and storage period.

**Overall acceptability:** Mean scores of overall acceptability (Table 4.20) of dry vegetable prepared from frozen peas indicated that overall acceptability was almost similar in HVP-01-29 and NDVP-08 variety on 0, 30$^{th}$, 60$^{th}$ and 90$^{th}$ days of storage and lied in liked moderately category. Significantly higher scores for overall acceptability were observed in Azad variety on 0, 30$^{th}$, 60$^{th}$ and 90$^{th}$ day of storage. But, still they were in

liked moderately category. Non significant differences in mean scores of overall acceptability of dry vegetable prepared by frozen peas was noticed. This indicated that there was no change in overall acceptability of frozen peas during storage.

Mean scores of overall acceptability of dry vegetable prepared from sun dried peas indicated that overall acceptability was almost similar in HVP-01-29 and NDVP-08 variety on 0, $30^{th}$, $60^{th}$ and $90^{th}$ day of storage and was in liked moderately category. Significantly ($P<0.05$) higher scores for overall acceptability were observed in Azad variety on 0, $30^{th}$, $60^{th}$ and $90^{th}$ day of storage. But still they were in liked moderately category. Non significant differences in mean scores of overall acceptability of dry vegetable prepared from sun dried peas were observed during the total period of storage. This indicated that there was no change in the overall acceptability of sun dried peas during storage.

Mean scores of overall acceptability of dry vegetable prepared from oven dried peas showed that overall acceptability was similar in dry vegetable prepared from Azad and NDVP-08 variety on 0, $30^{th}$, $60^{th}$ and $90^{th}$ day of storage and they were in category of ódiked moderatelyô. Significantly ($P<0.05$) lower scores for overall acceptability were observed in HVP-01-29 variety throughout the storage period. They lied in liked moderately category. Non significant differences in mean scores of overall acceptability of dry vegetable prepared from sun dried peas were observed during the total period of storage. Thus, overall acceptability of sun dried peas remained unchanged during storage.

**Table 4.20 : Effect of storage on mean scores of overall acceptability of dry vegetable prepared from frozen and dried pea varieties**

| Variety | Storage period (days) | | | | |
|---|---|---|---|---|---|
| **Freezing** | **0** | **30** | **60** | **90** | **CD (<0.05)** |
| HVP-01-29 | 7.40±0.04 | 7.30±0.04 | 7.20±0.04 | 7.20±0.05 | 0.13 |
| Azad | 7.90±0.02 | 7.70±0.08 | 7.60±0.07 | 7.70±0.08 | 0.20 |
| NDVP-08 | 7.50±0.04 | 7.50±0.03 | 7.40±0.04 | 7.30±0.04 | 0.18 |
| **CD (<0.05)** | 0.11 | 0.16 | 0.14 | 0.15 | |
| **Sun drying** | | | | | |
| HVP-01-29 | 7.40±0.05 | 7.30±0.05 | 7.20±0.04 | 7.10±0.04 | 0.13 |
| Azad | 7.80±0.10 | 7.70±0.06 | 7.70±0.09 | 7.60±0.08 | 0.14 |
| NDVP-08 | 7.40±0.06 | 7.40±0.04 | 7.30±0.04 | 7.30±0.08 | 0.12 |
| **CD (<0.05)** | 0.22 | 0.15 | 0.22 | 0.21 | |
| **Oven drying** | | | | | |
| HVP-01-29 | 7.40±0.07 | 7.40±0.15 | 7.30±0.16 | 7.20±0.14 | 0.15 |
| Azad | 7.80±0.03 | 7.70±0.03 | 7.70±0.07 | 7.60±0.04 | 0.14 |
| NDVP-08 | 7.70±0.09 | 7.70±0.05 | 7.60±0.07 | 7.50±0.04 | 0.16 |
| **CD (<0.05)** | 0.21 | 0.27 | 0.24 | 0.26 | |
| **CD (<0.05) :** | | | | | |
| HVP-01-29 | NS | NS | NS | NS | |
| Azad | NS | NS | NS | NS | |
| NDVP-08 | NS | NS | NS | NS | |

Values are mean ± SE of ten replicates

Non-significant (P<0.05) difference was observed in the mean scores of overall acceptability of dry vegetable prepared from variety HVP-01-29 during all the three treatments i.e. freezing, sun drying and oven drying and also during the period of storage. Similarly non-significant (P<0.05) differences were observed for other two varieties i.e. Azad and NDVP-08 for treatments and storage period.

**Curry vegetable:**

**Colour:** Mean scores of colour of curry vegetable prepared from frozen pea showed that colour was almost similar in curry vegetable prepared from all the three varieties i.e. HVP-01-29, Azad and NDVP-08 on 0, $30^{th}$, $60^{th}$ and $90^{th}$ day of storage and they were in category of ódiked moderatelyô. Non-significant (P<0.05) differences in mean scores of colour (Table 4.21) of curry vegetable prepared by frozen peas were observed during the total period of storage. This showed that colour remained same in frozen peas throughout storage period.

Mean scores of colour of curry vegetable prepared from sun dried peas showed that colour was almost similar in curry vegetable prepared from the varieties i.e. HVP-01-29, Azad and NDVP-08 on 0, $30^{th}$, $60^{th}$ and $90^{th}$ day of storage and they were liked moderately. Non-significant (P<0.05) difference in mean scores of colour of curry vegetable prepared by sun-dried peas was observed during the total period of storage. This indicated that there was no change in the colour of sun-dried peas during storage.

**Table 4.21 : Effect of storage on mean scores of colour of curry vegetable prepared from frozen and dried pea varieties**

| Variety | Storage period (days) | | | | |
|---|---|---|---|---|---|
| **Freezing** | **0** | **30** | **60** | **90** | **CD (<0.05)** |
| HVP-01-29 | 7.70±0.15 | 7.70±0.15 | 7.50±0.00 | 7.40±0.00 | NS |
| Azad | 7.80±0.13 | 7.70±0.15 | 7.70±0.15 | 7.70±0.15 | NS |
| NDVP-08 | 7.80±0.13 | 7.80±0.13 | 7.70±0.13 | 7.60±0.13 | NS |
| **CD (<0.05)** | NS | NS | NS | NS | |
| **Sun drying** | | | | | |
| HVP-01-29 | 7.80±0.13 | 7.70±0.15 | 7.70±0.15 | 7.60±0.16 | NS |
| Azad | 7.80±0.13 | 7.70±0.15 | 7.60±0.13 | 7.50±0.15 | NS |
| NDVP-08 | 7.70±0.15 | 7.70±0.15 | 7.70±0.15 | 7.60±0.16 | NS |
| **CD (<0.05)** | NS | NS | NS | NS | |
| **Oven drying** | | | | | |
| HVP-01-29 | 7.80±0.13 | 7.70±0.00 | 7.60±0.16 | 7.60±0.13 | NS |
| Azad | 7.80±0.13 | 7.70±0.15 | 7.70±0.13 | 7.70±0.15 | NS |
| NDVP-08 | 7.80±0.13 | 7.80±0.13 | 7.80±0.13 | 7.70±0.10 | NS |
| **CD (<0.05)** | NS | NS | NS | NS | |
| **CD (<0.05):** | | | | | |
| HVP-01-29 | NS | NS | NS | NS | |
| Azad | NS | NS | NS | NS | |
| NDVP-08 | NS | NS | NS | NS | |

Values are mean ± SE of ten replicates

Mean scores of colour of curry vegetable prepared from oven dried peas indicated that colour was almost similar in curry vegetable prepared from the varieties i.e. HVP-01-29, Azad and NDVP-08 on 0, 30$^{th}$, 60$^{th}$ and 90$^{th}$ day of storage and they were in category ñliked moderatelyò. Non-significant differences in mean scores of colour of curry vegetable prepared by oven dried peas were observed during the total period of storage. This showed that colour remained same during storage.

Non-significant difference was observed in mean scores of colour of curry vegetable prepared from variety HVP-01-29 during all the three treatments i.e. freezing, sun drying and oven drying and also during the period of storage. Similarly, non-significant ($P<0.05$) differences in mean scores of colour of curry vegetable prepared from other two varieties i.e. Azad and NDVP-08 were observed for treatments and storage period.

**Appearance:** Mean scores of appearance of curry vegetable prepared from frozen peas indicated that appearance was almost similar in curry vegetable prepared from the three varieties i.e. HVP-01-29, Azad and NDVP-08 on 0, 30$^{th}$, 60$^{th}$ and 90$^{th}$ day of storage and they were liked moderately. Non-significant ($P<0.05$) differences in mean scores of appearance of curry vegetable prepared by frozen peas were observed during the total period of storage. This showed that appearance of frozen peas remained unchanged (Table 4.22).

Mean scores of appearance of curry vegetable prepared from sun dried peas indicated that appearance was almost similar in curry vegetable prepared from the varieties i.e. HVP-01-29, Azad and NDVP-08 on 0, 30$^{th}$, 60$^{th}$ and 90$^{th}$ day of storage and they were liked moderately.

**Table 4.22: Effect of storage on mean scores of appearance of curry vegetable prepared from frozen and dried pea varieties**

| Variety | Storage period (days) | | | | |
|---|---|---|---|---|---|
| **Freezing** | **0** | **30** | **60** | **90** | **CD (<0.05)** |
| HVP-01-29 | 7.70±0.15 | 7.70±0.15 | 7.70±0.13 | 7.60±0.00 | NS |
| Azad | 7.80±0.13 | 7.70±0.15 | 7.70±0.13 | 7.60±0.13 | NS |
| NDVP-08 | 7.70±0.15 | 7.60±0.16 | 7.60±0.15 | 7.50±0.15 | NS |
| **CD (<0.05)** | NS | NS | NS | NS | |
| **Sun drying** | | | | | |
| HVP-01-29 | 7.70±0.15 | 7.70±0.15 | 7.60±0.16 | 7.50±0.16 | NS |
| Azad | 7.80±0.13 | 7.60±0.15 | 7.60±0.15 | 7.40±0.15 | NS |
| NDVP-08 | 7.70±0.15 | 7.70±0.15 | 7.60±0.15 | 7.40±0.16 | NS |
| **CD (<0.05)** | NS | NS | NS | NS | |
| **Oven drying** | | | | | |
| HVP-01-29 | 7.70±0.15 | 7.70±0.13 | 7.70±0.15 | 7.60±0.13 | NS |
| Azad | 7.80±0.13 | 7.70±0.15 | 7.60±0.10 | 7.50±0.15 | NS |
| NDVP-08 | 7.70±0.15 | 7.70±0.13 | 7.60±0.15 | 7.50±0.15 | NS |
| **CD (<0.05)** | NS | NS | NS | NS | |
| **CD (<0.05) :** | | | | | |
| HVP-01-29 | NS | NS | NS | NS | |
| Azad | NS | NS | NS | NS | |
| NDVP-08 | NS | NS | NS | NS | |

Values are mean ± SE of ten replicates

Non-significant (P<0.05) differences in mean scores of appearance of curry vegetable prepared by sun dried peas were observed during the total period of storage. This indicated that there was no change in the appearance of sun dried peas during storage.

Mean scores of appearance of curry vegetable prepared from oven dried peas indicated that appearance of the curry vegetable prepared from the varieties i.e. HVP-01-29, Azad and NDVP-08 was almost similar on 0, 30$^{th}$, 60$^{th}$ and 90$^{th}$ day of storage and they were in the category of ñliked moderatelyò. Non-significant (P<0.05) differences in mean scores of appearance of curry vegetable prepared by oven dried peas were observed during the total period of storage. This indicted that appearance of oven dried peas remained same during storage.

Non-significant (P<0.05) difference was observed in mean scores of appearance of curry vegetable prepared from variety HVP-01-29 during all the three treatments i.e. freezing, sun drying and oven drying and also during the period of storage. Similarly, non-significant (P<0.05) differences in mean scores of appearance of curry vegetable prepared from other two varieties i.e. Azad and NDVP-08 were observed for treatments and storage period.

**Flavour:** Mean scores of flavour of curry vegetable prepared from frozen peas indicated that flavour was almost similar in HVP-01-29 and Azad variety on 0, 30$^{th}$, 60$^{th}$ and 90$^{th}$ day of storage and was in liked moderately category. Significantly (P<0.05) lower scores for flavour (Table 4.23) were observed in NDVP-08 variety but they were also in ólikedmoderatelyô category. Non-significant (P<0.05) differences in mean scores of flavour of curry vegetable prepared by frozen peas were observed during the total period of storage. This indicated that there was no change in the flavour of frozen peas during storage.

**Table 4.23 : Effect of storage on mean scores of flavour of curry vegetable prepared from frozen and dried pea varieties**

| Variety | Storage period (days) | | | | |
|---|---|---|---|---|---|
| **Freezing** | **0** | **30** | **60** | **90** | **CD (<0.05)** |
| HVP-01-29 | 7.60±0.16 | 7.50±0.16 | 7.40±0.16 | 7.40±0.16 | NS |
| Azad | 7.90±0.10 | 7.60±0.16 | 7.70±0.15 | 7.70±0.15 | NS |
| NDVP-08 | 7.20±0.13 | 7.20±0.13 | 7.30±0.15 | 7.20±0.15 | NS |
| **CD (<0.05)** | 0.39 | 0.37 | 0.38 | 0.43 | |
| **Sun drying** | | | | | |
| HVP-01-29 | 7.20±0.13 | 7.00±0.00 | 7.00±0.13 | 7.00±0.00 | NS |
| Azad | 7.90±0.10 | 7.90±0.10 | 7.90±0.10 | 7.80±0.13 | NS |
| NDVP-08 | 7.30±0.15 | 7.00±0.00 | 7.00±0.00 | 7.00±0.00 | NS |
| **CD (<0.05)** | 0.37 | 0.16 | 0.27 | 0.22 | |
| **Oven drying** | | | | | |
| HVP-01-29 | 7.60±0.16 | 7.70±0.15 | 7.40±0.16 | 7.30±0.15 | NS |
| Azad | 7.90±0.10 | 7.70±0.15 | 7.60±0.16 | 7.70±0.15 | NS |
| NDVP-08 | 7.70±0.13 | 7.60±0.16 | 7.60±0.15 | 7.60±0.15 | NS |
| **CD (<0.05)** | NS | NS | NS | NS | |
| **CD (<0.05) :** | | | | | |
| HVP-01-29 | 0.34 | 0.37 | 0.35 | 0.37 | |
| Azad | NS | NS | NS | NS | |
| NDVP-08 | 0.34 | 0.34 | 0.36 | 0.33 | |

Values are mean ± SE of ten replicates

Mean scores of flavour of curry vegetable prepared from sun dried peas indicated that flavour was almost similar in varieties i.e. HVP-01-29 and NDVP-08 on 0, $30^{th}$, $60^{th}$ and $90^{th}$ day of storage and was in liked moderately category. Significantly ($P<0.05$) higher scores for flavour were observed in Azad variety but they were also liked moderately. Non-significant ($P<0.05$) differences in mean sores of flavour of curry vegetable prepared by sun dried peas were observed during the total period of storage. This showed that there was no change in flavour of sun dried peas during storage.

Mean scores of flavour of curry vegetable prepared from oven dried peas showed that flavour was almost similar in curry vegetable prepared from the varieties i.e. HVP-01-29, Azad and NDVP-08 on 0, $30^{th}$, $60^{th}$ and $90^{th}$ day of storage and they were liked moderately. Non-significant ($P<0.05$) differences in mean scores of flavour of curry vegetable prepared by oven dried peas were observed during the total period of storage. This showed that there was no change in the flavour of oven dried peas during storage.

Significant difference was observed in the mean scores of flavour of curry vegetable prepared from variety HVP-01-29 during all the three treatments i.e. freezing, sun drying and oven drying and also during the period of storage. While non-significant ($P<0.05$) differences were observed in the mean scores of flavour of curry vegetable prepared from variety Azad during all treatments and also during the period of storage.

**Texture:** Mean scores of texture of curry vegetable prepared from frozen peas showed that texture (Table 4.24) was almost similar in dry vegetable prepared from the varieties HVP-01-29, Azad and NDVP-08 on 0, $30^{th}$,

60th and 90th day of storage and they were liked moderately. Non-significant differences in mean scores of texture of dry vegetable prepared by frozen peas were observed during the total period of storage. This indicated that there was no change in the texture of frozen peas during storage.

Mean scores of texture of curry vegetable prepared from sun dried peas indicated that colour was almost similar in HVP-01-29 and NDVP-08 variety on 0 day of storage as well as on 0, 30th, 60th and 90th day of storage and was in liked moderately category. Significantly higher scores for texture were observed in Azad variety on 0, 30th, 60th and 90th day of storage. But still they were in liked moderately category. Non-significant difference in mean scores of texture of curry vegetable prepared from sun dried peas were observed during storage. This showed that there was no change in the texture of sun dried peas during storage.

Mean scores of texture of curry vegetable prepared from oven dried peas indicated that texture was almost similar in curry vegetable prepared from the varieties i.e. HVP-01-29, Azad and NDVP-08 on 0, 30th, 60th and 90th day of storage and they were liked moderately. Non-significant ($P<0.05$) differences in mean scores of texture of curry vegetable prepared by oven dried peas were observed during the total period of storage. This indicated that texture of oven dried peas remained unchanged during storage.

**Table 4.24 : Effect of storage on mean scores of texture of curry vegetable prepared from frozen and dried pea varieties**

| Variety | Storage period (days) | | | | |
|---|---|---|---|---|---|
| **Freezing** | **0** | **30** | **60** | **90** | **CD (<0.05)** |
| HVP-01-29 | 7.60±0.16 | 7.60±0.16 | 7.50±0.16 | 7.30±0.15 | NS |
| Azad | 7.90±0.10 | 7.70±0.15 | 7.60±0.16 | 7.50±0.16 | NS |
| NDVP-08 | 7.50±0.15 | 7.30±0.16 | 7.30±0.16 | 7.20±0.16 | NS |
| **CD (<0.05)** | NS | NS | NS | NS | |
| **Sun drying** | | | | | |
| HVP-01-29 | 7.20±0.13 | 7.20±0.13 | 7.00±0.00 | 7.00±0.00 | NS |
| Azad | 7.90±0.10 | 7.90±0.10 | 7.80±0.13 | 7.80±0.13 | NS |
| NDVP-08 | 7.20±0.13 | 7.20±0.13 | 7.20±0.13 | 7.00±0.00 | NS |
| **CD (<0.05)** | 0.35 | 0.35 | 0.31 | 0.22 | |
| **Oven drying** | | | | | |
| HVP-01-29 | 7.50±0.16 | 7.50±0.10 | 7.40±0.16 | 7.30±0.15 | NS |
| Azad | 7.90±0.10 | 7.80±0.13 | 7.60±0.16 | 7.60±0.16 | NS |
| NDVP-08 | 7.80±0.15 | 7.80±0.13 | 7.70±0.15 | 7.60±0.10 | NS |
| **CD (<0.05)** | NS | NS | NS | NS | |
| **CD (<0.05) :** | | | | | |
| HVP-01-29 | NS | NS | NS | NS | |
| Azad | NS | NS | NS | NS | |
| NDVP-08 | 0.40 | 0.41 | 0.43 | 0.32 | |

Values are mean ± SE of ten replicates

Non-significant differences were observed in mean scores of texture of curry vegetable prepared from varieties i.e. HVP-01-29 and Azad during all the three treatments i.e. freezing, sun drying and oven drying and also during the period of storage. Whereas, significant ($P<0.05$) difference was observed in mean scores of texture of curry vegetable prepared from variety NDVP-08 during all the treatments and storage period.

**Taste:** Mean scores of taste of curry vegetable (Table 4.25) prepared from frozen peas showed that taste was almost similar in curry vegetable prepared from the varieties i.e. HVP-01-29, Azad and NDVP-08 on 0, $30^{th}$, $60^{th}$ and $90^{th}$ day of storage and they were liked moderately. Non-significant differences ($P<0.05$) in mean scores of taste of curry vegetable prepared by frozen peas were observed during the total period of storage. This showed that there was no change in the taste of frozen peas during storage.

Mean scores of taste of curry vegetable prepared from sun dried peas showed that taste was almost similar in curry vegetable prepared from the varieties i.e. HVP-01-29, Azad, NDVP-08 on 0, $30^{th}$, $60^{th}$ and $90^{th}$ day of storage and they were liked moderately. Non-significant differences in mean scores of taste of curry vegetable prepared by sun dried peas were observed during the total period of storage. This indicated that there was no change in the taste of sun dried peas during storage.

Mean scores of taste of curry vegetable prepared from oven dried peas indicated that taste was almost similar in curry vegetable prepared from HVP-01-29 and NDVP-08 variety on 0, $30^{th}$, $60^{th}$ and $90^{th}$ day of

**Table 4.25 : Effect of storage on mean scores of taste of curry vegetable prepared from frozen and dried pea varieties**

| Variety | Storage period (days) | | | | |
|---|---|---|---|---|---|
| **Freezing** | **0** | **30** | **60** | **90** | **CD (<0.05)** |
| HVP-01-29 | 7.60±0.16 | 7.60±0.16 | 7.50±0.16 | 7.30±0.15 | NS |
| Azad | 7.90±0.10 | 7.80±0.13 | 7.70±0.15 | 7.70±0.15 | NS |
| NDVP-08 | 7.60±0.16 | 7.60±0.16 | 7.50±0.16 | 7.40±0.15 | NS |
| **CD (<0.05)** | NS | NS | NS | NS | |
| **Sun drying** | | | | | |
| HVP-01-29 | 7.60±0.16 | 7.50±0.16 | 7.50±0.16 | 7.40±0.16 | NS |
| Azad | 7.90±0.10 | 7.80±0.13 | 7.80±0.13 | 7.80±0.13 | NS |
| NDVP-08 | 7.60±0.16 | 7.50±0.16 | 7.50±0.16 | 7.40±0.16 | NS |
| **CD (<0.05)** | NS | NS | NS | NS | |
| **Oven drying** | | | | | |
| HVP-01-29 | 7.60±0.16 | 7.60±0.15 | 7.50±0.13 | 7.40±0.00 | NS |
| Azad | 7.90±0.10 | 7.90±0.10 | 7.80±0.13 | 7.80±0.13 | NS |
| NDVP-08 | 7.40±0.16 | 7.40±0.16 | 7.40±0.16 | 7.30±0.16 | NS |
| **CD (<0.05)** | 0.42 | 0.41 | 0.39 | 0.35 | |
| **CD (<0.05) :** | | | | | |
| HVP-01-29 | NS | NS | NS | NS | |
| Azad | NS | NS | NS | NS | |
| NDVP-08 | NS | NS | NS | NS | |

Values are mean ± SE of ten replicates

storage and they were liked moderately. Significantly higher scores for taste were observed in Azad variety on 0, 30$^{th}$, 60$^{th}$ and 90$^{th}$ day of storage. But they were also in liked moderately category. Non-significant ($P<0.05$) differences in mean scores of taste of dry vegetable prepared from oven dried peas were observed during storage. This indicated that taste of oven dried peas remained unchanged during storage.

Non-significant ($P<0.05$) difference was observed in mean scores of curry vegetable prepared from variety HVP-01-29 during all the three treatments i.e. freezing, sun drying and oven drying and also during the period of storage. Similarly, non-significant ($P<0.05$) differences in mean scores of taste of curry vegetable prepared from varieties i.e. Azad and NDVP-08 varieties were observed during all the treatments and period of storage.

**Overall acceptability:** Mean scores of overall acceptability of curry vegetable prepared from frozen peas showed that overall acceptability was almost similar in curry vegetable prepared from the varieties i.e. HVP-01-29, Azad and NDVP-08 on 0, 30$^{th}$, 60$^{th}$ and 90$^{th}$ day of storage and they were in liked moderately category (Table 4.26). Non-significant ($P<0.05$) differences in mean scores of overall acceptability of curry vegetable prepared by frozen peas were observed during the total period of storage. This showed that overall acceptability of frozen peas remained same during storage.

Mean scores of overall acceptability of curry vegetable prepared from sun dried peas indicated that overall acceptability was almost similar in HVP-01-29 and NDVP-08 variety on 0 day of storage as well

**Table 4.26 : Effect of storage on mean scores of overall acceptability of curry vegetable prepared from frozen and dried pea varieties**

| Variety | Storage period (days) | | | | |
|---|---|---|---|---|---|
| **Freezing** | **0** | **30** | **60** | **90** | **CD (<0.05)** |
| HVP-01-29 | 7.60±0.15 | 7.60±0.14 | 7.40±0.11 | 7.40±0.08 | NS |
| Azad | 7.80±0.07 | 7.70±0.14 | 7.70±0.13 | 7.60±0.13 | NS |
| NDVP-08 | 7.50±0.03 | 7.50±0.09 | 7.50±0.08 | 7.30±0.08 | NS |
| **CD (<0.05)** | 0.28 | NS | NS | NS | |
| **Sun drying** | | | | | |
| HVP-01-29 | 7.50±0.04 | 7.40±0.07 | 7.40±0.07 | 7.30±0.03 | NS |
| Azad | 7.80±0.07 | 7.80±0.08 | 7.80±0.10 | 7.60±0.10 | NS |
| NDVP-08 | 7.50±0.04 | 7.40±0.07 | 7.40±0.07 | 7.30±0.03 | NS |
| **CD (<0.05)** | 0.16 | 0.21 | 0.24 | 0.23 | |
| **Oven drying** | | | | | |
| HVP-01-29 | 7.60±0.13 | 7.50±0.08 | 7.40±0.10 | 7.40±0.09 | NS |
| Azad | 7.80±0.07 | 7.70±0.08 | 7.70±0.10 | 7.70±0.10 | NS |
| NDVP-08 | 7.70±0.03 | 7.70±0.13 | 7.60±0.13 | 7.60±0.08 | NS |
| **CD (<0.05)** | NS | NS | NS | NS | |
| **CD (<0.05) :** | | | | | |
| HVP-01-29 | NS | NS | NS | NS | |
| Azad | NS | NS | NS | NS | |
| NDVP-08 | NS | NS | NS | NS | |

Values are mean ± SE of ten replicates

as on 0, 30th, 60th and 90th day of storage and was in liked moderately category. Significantly (P<0.05) higher scores for overall acceptability were observed in Azad variety on 0, 30th, 60th and 90th day of storage. Still these lied in liked moderately category. Mean scores of overall acceptability of curry vegetable prepared from sun dried peas was found to be significantly similar during storage. This indicated that there was no change in the overall acceptability of sun dried peas during storage.

Mean scores of overall acceptability of curry vegetable prepared from over dried peas showed that overall acceptability was almost similar in curry vegetable prepared from the varieties i.e. HVP-01-29, Azad and NDVP-08 on 0, 30th, 60th and 90th day of storage and they were liked moderately. Non-significant (P<0.05) differences in mean scores of overall acceptability of curry vegetable prepared by oven dried peas were observed during the total period of storage. This indicated that overall acceptability of oven dried peas remained unchanged during storage.

Non-significant (P<0.05) difference was observed in mean scores of overall acceptability of curry vegetable prepared from variety HVP-01-29 during all the three treatments i.e. freezing, sun drying and oven drying and also during the period of storage. Similarly non-significant (P<0.05) differences were observed for other two varieties i.e. Azad and NDVP-08 for treatments and storage period.

There was no significant difference among organoleptic characteristics of pea dish prepared from dehydrated product even after six months of storage (Arora and Bakshi, 1994). Jaswinder (2003) concluded that french beans, okra and capsicum could be stored for a period of six months at ï 20 to ï 25°C without any significantly adverse

changes in organoleptic characteristics. Santosh (2005) also studied the effect of storage on organoleptic acceptability of mixed vegetable prepared from frozen and dehydrated baby corn during storage of 3 months. She found that mixed vegetable prepared from frozen and dehydrated baby corn was acceptable till the end of storage period of 90 days.

**Nutritional evaluation**

Dehydrated and frozen peas were analyzed for proximate composition, carbohydrates, *in vitro* digestibility, total minerals, antinutrients, vitamins and pigments at regular intervals of 0, 30, 60 and 90 days.

**Proximate composition**

**Moisture:** Moisture content (Table 4.27) in frozen peas varied from 77.00 to 79.18 per cent in various varieties throughout the storage period. There was significant decline in moisture content during 0, $30^{th}$, $60^{th}$ and $90^{th}$ day of storage, which varied from 0.61 to 1.19 per cent. Significant difference in moisture content of various frozen pea varieties was noticed. Azad pea was found to contain maximum moisture content followed by HVP-01-29 and NDVP-08. Similar trend was noticed among the varieties during the storage. This decline may be attributed to vapour pressure difference and also the polythene bags may be permeable to water vapours. Similar findings has been reported by Pawar *et al* (1994).

**Table 4.27 : Effect of storage on moisture content (g/100g, dry matter basis) of frozen and dried pea varieties**

| Variety | Storage period (days) | | | | |
|---|---|---|---|---|---|
| **Freezing** | **0** | **30** | **60** | **90** | **CD (<0.05)** |
| HVP-01-29 | 78.42±0.01 | 77.71±0.08 (0.71) | 77.61±0.01 (1.03) | 77.49±0.01 (1.19) | 0.03 |
| Azad | 79.18±0.01 | 78.69±0.00 (0.61) | 78.59±0.01 (0.74) | 78.31±0.01 (1.09) | 0.05 |
| NDVP-08 | 77.90±0.01 | 77.31±0.01 (0.70) | 77.24±0.01 (0.84) | 77.00±0.01 (1.15) | 0.09 |
| **CD (<0.05)** | 0.03 | 0.03 | 0.04 | 0.04 | |
| **Sun drying** | | | | | |
| HVP-01-29 | 6.17±0.01 | 6.52±0.01 (5.60) | 6.72±0.01 (8.90) | 6.91±0.01 (11.90) | 0.04 |
| Azad | 6.74±0.02 | 7.16±0.01 (6.20) | 7.42±0.01 (10.08) | 7.62±0.03 (13.00) | 0.03 |
| NDVP-08 | 6.11±0.01 | 6.41±0.02 (4.90) | 6.60±0.03 (8.01) | 6.82±0.01 (11.60) | 0.08 |
| **CD (<0.05)** | 0.04 | 0.05 | 0.03 | 0.03 | |
| **Oven drying** | | | | | |
| HVP-01-29 | 6.10±0.01 | 6.42±0.01 (5.40) | 6.63±0.01 (8.68) | 6.80±0.02 (11.47) | 0.04 |
| Azad | 6.72±0.01 | 7.13±0.02 (6.13) | 7.38±0.03 (9.82) | 7.58±0.01 (12.79) | 0.04 |
| NDVP-08 | 6.08±0.01 | 6.38±0.01 (4.60) | 6.56±0.01 (7.89) | 6.78±0.01 (11.51) | 0.07 |
| **CD (<0.05)** | 0.04 | 0.04 | 0.04 | 0.04 | |
| **CD (<0.05):** | | | | | |
| HVP-01-29 | 0.04 | 0.05 | 0.04 | 0.04 | |
| Azad | 0.03 | 0.03 | 0.03 | 0.04 | |
| NDVP-08 | 0.03 | 0.04 | 0.04 | 0.04 | |

Values are mean ± SE three independent determination

Figures in parenthesis indicate percent change compared to zero day

Moisture content in sun dried peas ranged from 6.11 to 7.52 per cent in various varieties during the storage period. Significant increase of 4.90 to 13.00 per cent was observed during 0, 30$^{th}$, 60$^{th}$ and 90$^{th}$ day of storage. Significant difference in moisture content of various sun dried varieties was noticed. Azad variety was found to contain maximum amount of moisture content followed by HVP-01-29 and NDVP-08. Similar trend was observed among the varieties during the storage.

Moisture content in oven dried peas varied from 6.08 to 7.58 per cent in various varieties during the storage period. Significant increase i.e. 4.60 to 12.79 per cent was estimated during 0, 30$^{th}$, 60$^{th}$ and 90$^{th}$ day of storage. Significant difference was observed in moisture content of various oven dried varieties. Varietal difference remained significant during storage. Azad variety was found to contain maximum moisture content followed by HVP-01-29 and NDVP-08. The results are in conformity with the published literature (Arora and Bakshi, 1994; Pawar *et al.* 1994). Sheriful (2002) reported a range of 5.92 to 7.53 per cent moisture content during storage of various dehydrated pea varieties.

Significant difference was observed in the moisture content of variety HVP-01-29 during all the treatments and storage. Similarly significant differences were observed for the other two varieties i.e. Azad and NDVP-08 for all the treatments and storage. Moisture content of sundried and oven dried peas was almost similar during the storage period.

**Crude protein:** Protein content in frozen peas varied from 22.16 to 23.93 per cent in various varieties throughout the storage period (Table 4.28). There was significant decline in protein content during 0, 30$^{th}$, 60$^{th}$ and 90$^{th}$ day of storage, which varied from 0.50 to 1.64 per cent. Difference in protein content of various frozen varieties was observed which was statistically significant. Azad variety was found to contain maximum protein content followed by NDVP-08 and HVP-01-29 variety. Same trend was observed among the various varieties during storage. Jaswinder (2003) also reported slight but non-significant decrease in protein content of frozen stored vegetables i.e. beans, okra and capsicum.

Protein content in sun dried peas ranged from 21.96 to 23.87 per cent in various varieties during the storage period. Significant decline of 1.42 to 2.05 per cent was observed during different intervals of storage period. Significant difference in protein content of various sun dried varieties was observed. Azad variety contained maximum protein content followed by NDVP-08 and HVP-01-29. Similar trend was noticed among the various varieties during storage.

Protein content in oven dried peas varied from 22.04 to 23.89 per cent in various varieties during the storage period. Decrease of 1.38 to 2.04 per cent was estimated during 0, 30$^{th}$, 60$^{th}$ and 90$^{th}$ day of storage. There was significant difference in protein content of various oven dried varieties. The highest protein content was estimated in Azad variety followed by NDVP-08 and HVP-01-29 variety. The trend remained unchanged among the various varieties throughout the storage. Similar

**Table 4.28 : Effect of storage on protein content (g/100g, dry matter basis) of frozen and dried pea varieties**

| Variety | Storage period (days) | | | | |
|---|---|---|---|---|---|
| **Freezing** | **0** | **30** | **60** | **90** | **CD (<0.05)** |
| HVP-01-29 | 22.53±0.01 | 22.40±0.01 ((0.57) | 22.32±0.008 (0.93) | 22.16±0.01 (1.64) | 0.03 |
| Azad | 23.93±0.02 | 23.81±0.02 (0.50) | 23.71±0.01 (0.91) | 23.56±0.01 (1.54) | 0.04 |
| NDVP-08 | 22.60±0.04 | 22.48±0.01 (0.53) | 22.39±0.01 (0.95) | 22.23±0.008 (1.50) | 0.09 |
| **CD (<0.05)** | 0.04 | 0.07 | 0.03 | 0.03 | |
| **Sun drying** | | | | | |
| HVP-01-29 | 22.42±0.01 | 22.10±0.008 (1.69) | 22.00±0.01 (1.87) | 21.96±0.01 (2.05) | 0.03 |
| Azad | 23.87±0.01 | 23.53±0.31 (1.42) | 23.44±0.31 (1.80) | 23.39±0.03 (2.01) | 0.10 |
| NDVP-08 | 22.46±0.01 | 22.10±0.01 (1.66) | 22.05±0.02 (1.82) | 22.00±0.01 (2.04) | 0.03 |
| **CD (<0.05)** | 0.04 | 0.05 | 0.04 | 0.04 | |
| **Oven drying** | | | | | |
| HVP-01-29 | 22.50±0.01 | 22.15±0.00 (1.55) | 22.10±0.04 (1.77) | 22.04±0.04 (2.04) | 0.02 |
| Azad | 23.89±0.01 | 23.54±0.03 (1.38) | 23.48±0.01 (1.76) | 23.41±0.00 (2.00) | 0.03 |
| NDVP-08 | 22.56±0.02 | 22.22±0.01 (1.52) | 22.16±0.01 (1.77) | 22.10±0.01 (2.03) | 0.05 |
| **CD (<0.05)** | 0.04 | 0.03 | 0.04 | 0.03 | |
| **CD (<0.05) :** | | | | | |
| HVP-01-29 | 0.04 | 0.03 | 0.04 | 0.03 | |
| Azad | 0.04 | 0.03 | 0.04 | 0.04 | |
| NDVP-08 | 0.05 | 0.04 | 0.04 | 0.03 | |

Values are mean ± SE three independent determination

Figures in parenthesis indicate percent change compared to zero day

decrease in protein content of dried peas during storage was observed by Kulesza and Gertig (1996). Sheriful (2002) noticed a decline of 0.19 to 0.31 percent in various pea cultivars during storage of dehydrated peas for 6 months. Decline of 6.67 to 22.76 percent was noticed during storage of 2 months of dehydrated peas treated by various treatments (Ruchika, 2004)

Significant difference was observed in the protein content of variety HVP-01-29 during all the treatments and storage. Similarly significant differences were observed for the other two varieties i.e. Azad and NDVP-08 for all the treatments and storage. Protein content of sundried and oven dried peas was almost same during the storage period.

**Fat:** Fat content in frozen peas ranged from 2.69 to 3.21 per cent in various varieties throughout the storage period. There was significant decline i.e. 3.09 to 9.03 per cent (Table 4.29) during 0, $30^{th}$, $60^{th}$ and $90^{th}$ day of storage. Significant difference in fat content of various frozen varieties was recorded. The maximum fat content was estimated in NDVP-08 variety followed by HVP-01-29 and Azad variety. Same trend was observed among the various varieties during storage. Non significant decline of 9.39 percent by the end of storage of 90 days in fat content of frozen baby corn was given by Santosh (2005)

Fat content in sun dried peas varied from 2.52 to 3.13 per cent in various varieties during the storage period. Significant decline in fat content during 0, $30^{th}$, $60^{th}$ and $90^{th}$ day of storage. The decline ranged from 4.05 to 14.86 per cent. Significant difference in fat content of various sun dried varieties was recorded. Fat content was found to be maximum in NDVP-08, followed by HVP-01-29 and Azad variety. Similar trend was observed among the various varieties during storage.

**Table 4.29 : Effect of storage on fat content (g/100g, dry matter basis) of frozen and dried pea varieties**

| Variety | Storage period (days) | | | | |
|---|---|---|---|---|---|
| **Freezing** | **0** | **30** | **60** | **90** | **CD (<0.05)** |
| HVP-01-29 | 2.99±0.01 | 2.89±0.04 (3.34) | 2.80±0.02 (6.35) | 2.72±0.21 (9.03) | 0.03 |
| Azad | 2.91±0.02 | 2.82±0.03 (3.09) | 2.75±0.01 (5.49) | 2.69±0.02 (7.56) | 0.04 |
| NDVP-08 | 3.21±0.01 | 3.11±0.01 (3.11) | 3.03±0.04 (5.60) | 2.94±0.01 (8.41) | 0.06 |
| **CD (<0.05)** | 0.04 | 0.04 | 0.09 | 0.06 | |
| **Sun drying** | | | | | |
| HVP-01-29 | 2.96±0.01 | 2.84±0.07 (4.05) | 2.69±0.01 (9.12) | 2.52±0.01 (14.86) | 0.08 |
| Azad | 2.85±0.05 | 2.69±0.04 (5.61) | 2.68±0.02 (5.96) | 2.65±0.02 (7.01) | 0.03 |
| NDVP-08 | 3.13±0.01 | 2.91±0.01 (7.02) | 2.85±0.01 (8.94) | 2.74±0.03 (12.46) | 0.04 |
| **CD (<0.05)** | 0.04 | 0.15 | 0.03 | 0.03 | |
| **Oven drying** | | | | | |
| HVP-01-29 | 2.97±0.02 | 2.85±0.02 (4.04) | 2.70±0.04 (9.09) | 2.54±0.01 (14.47) | 0.04 |
| Azad | 2.89±0.01 | 2.73±0.01 (5.53) | 2.72±0.02 (5.88) | 2.69±0.04 (6.92) | 0.04 |
| NDVP-08 | 3.17±0.03 | 2.95±0.04 (6.94) | 2.89±0.01 (8.83) | 2.78±0.01 (12.30) | 0.04 |
| **CD (<0.05)** | 0.05 | 0.05 | 0.04 | 0.04 | |
| **CD (<0.05) :** | | | | | |
| HVP-01-29 | NS | NS | NS | NS | |
| Azad | 0.04 | 0.04 | 0.06 | 0.03 | |
| NDVP-08 | 0.05 | 0.05 | 0.09 | 0.04 | |

Values are mean ± SE three independent determination

Figures in parenthesis indicate percent change compared to zero day

Fat content in oven dried peas ranged from 2.54 to 3.17 per cent in various varieties during the storage period. Significant decline of 4.04 to 14.47 per cent was noticed during the different storage intervals. Difference in fat content of various oven dried varieties was recorded and the difference was statically significant. Fat content was maximum in NDVP-08 variety followed by HVP-01-29 and Azad variety. The trend remained same among the various varieties during storage. Santosh (2005) recorded that fat content declined from 2.13 to 1.95 percent during storage of 3 months in dehydrated baby corn.

Non-significant difference was observed in the fat content of variety HVP-01-29 during all the treatments and storage. Whereas, significant differences were observed in fat content of the other two varieties (Azad and NDVP-08) for all treatments and storage. Fat content of sundried and oven dried peas was almost same during the storage period.

**Ash:** Ash content in frozen peas ranged from 4.45 to 4.86 percent (Table 4.30) in various varieties during the storage period. There was significant decline i.e. 1.29 to 4.32 per cent during 0, $30^{th}$, $60^{th}$ and $90^{th}$ day of storage. Significant difference in ash content of various frozen varieties was noticed. Azad variety contained maximum amount of ash content followed by NDVP-08 and HVP-01-29. Similar trend was observed among the various varieties during storage. The observed decrease in ash content of frozen peas may be due to leaching of minerals during thawing done during drying of peas for analysis. Similarly, in earlier study on frozen foods, Pawar *et al.* (1994) observed significant reduction in ash content of peas during 4½ months of frozen storage.

**Table 4.30 : Effect of storage on ash content (g/100g, dry matter basis) of frozen and dried pea varieties**

| Variety | Storage period (days) | | | | |
|---|---|---|---|---|---|
| **Freezing** | **0** | **30** | **60** | **90** | **CD (<0.05)** |
| HVP-01-29 | 4.65±0.01 | 4.59±0.01 (1.29) | 4.52±0.02 (2.79) | 4.46±0.01 (4.08) | 0.04 |
| Azad | 4.86±0.07 | 4.79±0.14 (1.23) | 4.72±0.01 (2.88) | 4.65±0.02 (4.32) | 0.06 |
| NDVP-08 | 4.62±0.01 | 4.56±0.01 (1.24) | 4.50±0.05 (2.59) | 4.45±0.01 (3.57) | 0.03 |
| **CD (<0.05)** | 0.15 | 0.21 | 0.04 | 0.04 | |
| **Sun drying** | | | | | |
| HVP-01-29 | 4.52±0.01 | 4.41±0.01 (2.43) | 4.33±0.03 (4.20) | 4.20±0.03 (7.07) | 0.03 |
| Azad | 4.83±0.02 | 4.73±0.04 (2.07) | 4.65±0.02 (3.72) | 4.53±0.01 (6.27) | 0.04 |
| NDVP-08 | 4.46±0.01 | 4.32±0.01 (3.13) | 4.25±0.01 (4.50) | 4.12±0.02 (7.62) | 0.05 |
| **CD (<0.05)** | 0.04 | 0.04 | 0.04 | 0.04 | |
| **Oven drying** | | | | | |
| HVP-01-29 | 4.54±0.03 | 4.43±0.03 (2.42) | 4.35±0.01 (4.18) | 4.22±0.03 (7.04) | 0.03 |
| Azad | 4.85±0.01 | 4.75±0.01 (2.06) | 4.68±0.01 (3.50) | 4.56±0.01 (5.97) | 0.04 |
| NDVP-08 | 4.47±0.02 | 4.34±0.04 (2.90) | 4.28±0.02 (4.25) | 4.15±0.02 (7.15) | 0.04 |
| **CD (<0.05)** | 0.04 | 0.01 | 0.03 | 0.05 | |
| **CD (<0.05):** | | | | | |
| HVP-01-29 | 0.03 | 0.04 | .03 | 0.04 | |
| Azad | 0.04 | 0.03 | 0.04 | 0.04 | |
| NDVP-08 | 0.04 | 0.04 | 0.04 | 0.04 | |

Values are mean ± SE three independent determination

Figures in parenthesis indicate percent change compared to zero day

Ash content in sun dried peas varied from 4.12 to 4.83 per cent in various varieties throughout the storage period. Significant decline of 2.07 to 7.62 per cent was noticed during intervals of storage. Difference in ash content of sun dried varieties was observed which was statistically significant. It was found that highest ash content was observed in Azad variety followed by HVP-01-29 and NDVP-08 variety. Similar trend was noticed among the various varieties during the storage.

Ash content in oven dried peas varied from 4.15 to 4.85 percent in various varieties during the storage period. There was significant decline i.e. 2.06 to 7.15 per cent during the different intervals of storage. It was observed that there was significant difference in ash content of various oven dried varieties. The maximum ash content was estimated in Azad variety followed by HVP-01-29 and NDVP-08. The trend remained unchanged among the various varieties during the storage period.

Significant difference was noticed in the ash content of variety HVP-01-29 during all the treatments and storage. Similarly, significant differences were observed for the other two varieties i.e. Azad and NDVP-08 for all the treatments and storage. Ash content of sundried and oven dried peas was almost similar throughout the storage period.

**Fibre:** Fibre content in frozen peas ranged from 7.73 to 8.90 per cent in various varieties during all the storage period. Decline of 0.85 to 3.14 per cent was observed during different intervals of storage. Significant difference in fibre content of various frozen varieties was observed. NDVP-08 variety was found to contain maximum fibre content followed by HVP-01-29 and Azad variety. The trend remained same during the storage of various varieties (Table 4.31). Significant decline (6.45%) in crude fibre of frozen baby corn has been reported by Santosh (2005).

**Table 4.31 : Effect of storage on fiber content (g/100g, dry matter basis) of frozen and dried pea varieties**

| Variety | Storage period (days) | | | | |
|---|---|---|---|---|---|
| **Freezing** | **0** | **30** | **60** | **90** | **CD (<0.05)** |
| HVP-01-29 | 8.16±0.02 | 8.09±0.05 (0.85) | 8.01±0.08 (1.83) | 7.93±0.01 (2.81) | 0.04 |
| Azad | 7.96±0.01 | 7.89±0.01 (0.87) | 7.81±0.02 (1.84) | 7.73±0.03 (2.88) | 0.05 |
| NDVP-08 | 8.90±0.021 | 8.81±0.01 (1.01) | 8.72±0.00 (2.02) | 8.62±0.02 (3.14) | 0.07 |
| **CD (<0.05)** | 0.04 | 0.02 | 0.10 | 0.05 | |
| **Sun drying** | | | | | |
| HVP-01-29 | 8.00±0.02 | 7.90±0.01 (1.25) | 7.86±0.02 (1.75) | 7.75±0.00 (3.12) | 0.03 |
| Azad | 7.80±0.03 | 7.71±0.01 (1.15) | 7.64±0.03 (2.05) | 7.55±0.02 (3.20) | 0.06 |
| NDVP-08 | 8.65±0.01 | 8.83±0.02 (1.38) | 8.44±0.01 (2.42) | 8.35±0.01 (3.35) | 0.08 |
| **CD (<0.05)** | 0.07 | 0.04 | 0.08 | 0.04 | |
| **Oven drying** | | | | | |
| HVP-01-29 | 8.02±0.02 | 7.92±0.01 (1.24) | 7.87±0.02 (1.87) | 7.76±0.03 (3.24) | 0.03 |
| Azad | 7.85±0.03 | 7.76±0.03 (1.14) | 7.69±0.01 (2.03) | 7.58±0.02 (3.43) | 0.04 |
| NDVP-08 | 8.68±0.01 | 8.55±0.02 (1.49) | 8.45±0.04 (3.22) | 8.35±0.01 (3.80) | 0.06 |
| **CD (<0.05)** | 0.04 | 0.05 | 0.06 | 0.07 | |
| **CD (<0.05):** | | | | | |
| HVP-01-29 | 0.05 | 0.06 | 0.05 | 0.03 | |
| Azad | 0.04 | 0.06 | 0.05 | 0.04 | |
| NDVP-08 | 0.05 | 0.04 | 0.03 | 0.05 | |

Values are mean ± SE three independent determination

Figures in parenthesis indicate percent change compared to zero day

Fibre content in sun dried peas varied from 7.55 to 8.65 per cent in various varieties during the storage period. Decline of 1.15 to 3.35 per cent was noticed during 0, 30$^{th}$, 60$^{th}$ and 90$^{th}$ day of storage, which was statistically significant. Significant difference in fibre content of sun dried peas was noticed. Maximum fibre content was noticed in HDVP-08 variety followed by HVP-01-29 and Azad variety. Same trend was observed among the various varieties throughout the storage.

Fibre content in oven dried peas ranged from 7.58 to 8.68 per cent during the storage period in various varieties. Significant decline of 1.14 to 3.80 per cent was observed during the 0, 30$^{th}$, 60$^{th}$ and 90$^{th}$ day of storage. There was significant difference in fibre content of various varieties. It was found that maximum fibre content was noticed in NDVP-08 variety followed by HVP-01-29 and Azad variety. Similar trend was observed among the various varieties during the storage. Santosh (2005) indicated that fibre content declined by 1.19 percent during the storage of dehydrated baby corn for 3 months.

Difference was observed in the fibre content of variety HVP-01-29 during all the treatments and storage, which was statistically significant. Similarly significant differences were observed for other two varieties i.e. Azad and NDVP-08 for all the treatments and storage. Fibre content of sundried and oven dried peas was almost similar during the storage period.

**Alcohol insoluble solid (AIS):** Alcohol insoluble solid content of frozen peas varied from 12.28 to 14.50 per cent in significant decline in alcohol insoluble solid content (Table 4.32) during different intervals of storage

which varied from 3.44 to 8.90 per cent. There was significant difference in AIS content of various frozen varieties. Azad was found to have maximum AIS content followed by HVP-01-29 and NDVP-08. Same trend was observed among the various varieties during storage.

AIS content of sun dried peas ranged from 42.19 to 59.00 per cent in various varieties during the storage period. Decline of 5.93 to 24.79 per cent was noticed in AIS content during 0, $30^{th}$, $60^{th}$ and $90^{th}$ day of storage. The decline was statistically significant. Significant difference was observed in AIS content of various sun dried varieties. It was found that Azad contain the maximum AIS content followed by NDVP-08 and HVP-01-29 variety. Similar trend was noticed among the various varieties during storage.

AIS content of oven dried peas varied from 43.67 to 60.10 per cent in various varieties during the storage period. Significant decline of 5.82 to 24.15 per cent was observed in AIS content during storage period. Significant difference in AIS content of various oven dried varieties was noticed. Azad variety was found to contain highest AIS content followed by NDVP-08 and HVP-01-29 variety.

Significant difference in the AIS content was observed in HVP-01-29 variety during all the treatments and storage. Similarly, significant differences were observed for other two varieties (Azad and NDVP-08) for all the treatments and storage.

**Table 4.32 : Effect of storage on Alcohol insoluble solid content (g/100g) of frozen and dried pea varieties**

| Variety | Storage period (days) | | | | |
|---|---|---|---|---|---|
| **Freezing** | **0** | **30** | **60** | **90** | **CD (<0.05)** |
| HVP-01-29 | 13.92±0.02 (1.43) | 13.42±0.01 (3.59) | 13.03±0.01 (6.39) | 12.68±0.03 (8.90) | 0.02 |
| Azad | 14.50±0.01 (1.27) | 14.00±0.02 (3.44) | 13.49±0.02 (6.96) | 13.22±0.01 (8.82) | 0.02 |
| NDVP-08 | 13.48±0.02 (1.56) | 12.95±0.03 (3.93) | 12.49±0.01 (7.34) | 12.28±0.02 (8.90) | 0.04 |
| **CD (<0.05)** | 0.02 | 0.03 | 0.04 | 0.03 | |
| **Sun drying** | | | | | |
| HVP-01-29 | 56.10±0.02 (2.0) | 52.20±0.02 (6.95) | 46.20±0.01 (17.82) | 42.19±0.01 (24.79) | 0.04 |
| Azad | 59.00±0.01 (0.80) | 55.50±0.03 (5.93) | 49.22±0.03 (16.57) | 46.61±0.04 (21.00) | 0.03 |
| NDVP-08 | 58.21±0.07 (1.94) | 54.48±0.01 (6.40) | 48.49±0.02 (16.69) | 44.66±0.01 (23.27) | 0.05 |
| **CD (<0.05)** | 0.14 | 0.01 | 0.04 | 0.04 | |
| **Oven drying** | | | | | |
| HVP-01-29 | 57.58±0.03 | 53.68±0.01 (6.77) | 47.58±0.01 (17.36) | 43.67±0.01 (24.15) | 0.03 |
| Azad | 60.10±0.02 | 56.64±0.02 (5.82) | 50.32±0.03 (16.27) | 47.71±0.03 (20.61) | 0.02 |
| NDVP-08 | 59.16±0.01 | 55.44±0.01 (6.28) | 49.44±0.00 (16.43) | 46.21±0.01 (22.88) | 0.07 |
| **CD (<0.05)** | 0.03 | 0.03 | 0.03 | 0.03 | |
| **CD (<0.05) :** | | | | | |
| HVP-01-29 | 0.03 | 0.03 | 0.04 | 0.04 | |
| Azad | 0.03 | 0.03 | 0.03 | 0.02 | |
| NDVP-08 | 0.14 | 0.03 | 0.04 | 0.03 | |

Values are mean ± SE three independent determination
Figures in parenthesis indicate percent change compared to zero day

AIS content was found to be decreased during storage. AIS contain cellulose, hemicelluloses, proteins, starch, pentosans etc. If the starch and other contents decreased, then AIS content also decreases. Das *et al.* (1992) reported that there was notable decrease in dry matter as well as AIS during storage of dehydrated peas. AIS content as reported by Ruchika (2004) declined from 5.02 to 14.90 percent in dehydrated peas treated by various treatments during storage of 60 days.

**Starch:** Starch content in frozen peas varied from 50.31 to 52.70 g/100g in various varieties during storage period. There was significant decline in starch content during 0, $30^{th}$, $60^{th}$ and $90^{th}$ day of storage, which varied from 0.23 to 0.94 per cent (Table 4.33). Significant difference in starch content of various frozen varieties was noticed. NDVP-08 variety contained the maximum starch content followed by HVP-01-29 and Azad variety. Same trend was observed among the various varieties during storage.

Starch content in sun dried varieties ranged from 41.70 to 44.35 g/100g in various varieties during storage. There was significant decline of 0.42 to 2.05 per cent during various intervals of storage. Significant difference in starch content of various varieties was observed. It was noticed that HVP-01-29 variety contained highest starch content followed by NDVP-08 and Azad variety. Similar trend was observed among the various varieties during storage.

Starch content in oven dried varieties varied from 48.58 to 49.05 g/100g during storage among various varieties. Significant decline of 0.40 to 1.71 per cent during 0, $30^{th}$, $60^{th}$ and $90^{th}$ day of storage was

**Table 4.33 : Effect of storage on starch content (g/100g, dry matter basis) of frozen and dried pea varieties**

| Variety | Storage period (days) | | | | |
|---|---|---|---|---|---|
| **Freezing** | **0** | **30** | **60** | **90** | **CD (<0.05)** |
| HVP-01-29 | 52.70±0.01 | 52.57±0.02 (0.24) | 52.42±0.02 (0.53) | 52.20±0.02 (0.94) | 0.02 |
| Azad | 50.70±0.02 | 50.58±0.01 (0.23) | 50.44±0.00 (0.59) | 50.31±0.03 (0.76) | 0.02 |
| NDVP-08 | 52.01±0.03 | 51.87±0.01 (0.26) | 51.71±0.03 (0.57) | 51.57±0.04 (0.84) | 0.09 |
| **CD (<0.05)** | 0.03 | 0.04 | 0.01 | 0.02 | |
| **Sun drying** | | | | | |
| HVP-01-29 | 44.35±0.02 | 44.31 ±0.02 (0.42) | 44.05±0.03 (0.67) | 43.44±0.02 (2.05) | 0.02 |
| Azad | 42.40 ±0.03 | 42.20±0.01 (0.47) | 41.90±0.02 (1.71) | 41.70±0.01 (1.65) | 0.02 |
| NDVP-08 | 43.68 ±0.01 | 43.38 ±0.03 (0.68) | 43.08±0.01 (1.37) | 42.86±0.00 (1.87) | 0.05 |
| **CD (<0.05)** | 0.08 | 0.02 | 0.02 | 0.02 | |
| **Oven drying** | | | | | |
| HVP-01-29 | 51.22±0.01 | 50.95±0.03 (0.52) | 50.62±0.01 (1.17) | 50.34±0.02 (1.71) | 0.02 |
| Azad | 49.25±0.04 | 49.05±0.01 (0.40) | 48.70±0.02 (1.11) | 48.58±0.01 (1.36) | 0.03 |
| NDVP-08 | 50.55±0.02 | 50.32±0.01 (0.45) | 50.01±0.00 (1.06) | 49.76±0.01 (1.56) | 0.06 |
| **CD (<0.05)** | 0.03 | 0.03 | 0.02 | 0.04 | |
| **CD (<0.05) :** | | | | | |
| HVP-01-29 | 0.03 | 0.02 | 0.02 | 0.02 | |
| Azad | 0.02 | 0.03 | 0.01 | 0.04 | |
| NDVP-08 | 0.03 | 0.04 | 0.01 | 0.03 | |

Values are mean ± SE three independent determination

Figures in parenthesis indicate percent change compared to zero day

noticed. There was significant difference in starch content of various varieties. It was observed that NDVP-08 variety contained maximum starch content followed by HVP-01-29 and Azad variety. The trend remained same among the various varieties during storage.

Significant difference was observed in starch content of variety HVP-01-29 during all the treatments and storage. Similarly, significant differences were observed for other varieties i.e. Azad and NDVP-08 for all the treatments and storage.

Starch content was found to be decreased during storage. It decreased due to hydrolysis of starch to sugars. Similar observations in starch content of peas during storage were observed by Das *et al.* (1993). According to them starch reduced during processing by 9.00 to 14.00 per cent. Sheriful (2002) also reported decline of 0.28 to 3.20 percent in starch content during the storage of 6 months of dehydrated peas of various cultivars. Starch content also declined from 43.20 to 27.20 percent in dehydrated peas treated by various treatments during storage of 60days (Ruchika, 2004). Lee (1989) reported that the starch sugar ratio of peas is associated with eating quality; high sugar and low starch content make for high quality.

**Total soluble sugar:** Total soluble sugar content in frozen peas varied from 7.59 to 7.90 g/100g in various varieties during the storage. There was significant decline of 1.89 to 4.38 per cent (Table 4.34) during 0, $30^{th}$, $60^{th}$ and $90^{th}$ day of storage. There was significant difference in total soluble sugar content of various frozen varieties. Azad was found to contain highest total soluble sugar content followed by NDVP-08 and HVP-01-29 variety. The similar trend was noticed among the various varieties throughout storage.

**Table 4.34 : Effect of storage on Total soluble sugar content (g/100g, dry matter basis) of frozen and dried pea varieties**

| Variety | Storage period (days) | | | | |
|---|---|---|---|---|---|
| **Freezing** | **0** | **30** | **60** | **90** | **CD (<0.05)** |
| HVP-01-29 | 7.30±0.08 | 7.16±0.01 (1.91) | 7.08±0.01 (3.01) | 6.98±0.01 (4.38) | 0.03 |
| Azad | 7.90±0.03 | 7.75±0.01 (1.89) | 7.64±0.04 (3.29) | 7.59±0.02 (3.92) | 0.02 |
| NDVP-08 | 7.76±0.01 | 7.61±0.03 (1.93) | 7.51±0.03 (3.22) | 7.42±0.03 (4.38) | 0.06 |
| **CD (<0.05)** | 0.03 | 0.03 | 0.03 | 0.03 | |
| **Sun drying** | | | | | |
| HVP-01-29 | 6.34±0.01 | 5.95±0.01 (6.15) | 5.45±0.01 (14.82) | 5.13±0.00 (19.08) | 0.03 |
| Azad | 6.96±0.02 | 5.60±0.04 (5.17) | 6.32+0.01 (9.19) | 5.87±0.01 (15.69) | 0.08 |
| NDVP-08 | 6.81±0.04 | 6.42+0.01 (5.72) | 5.93±0.03 (12.92) | 5.66±0.04 (16.88) | 0.09 |
| **CD (<0.05)** | 0.05 | 0.04 | 0.03 | 0.03 | |
| **Oven drying** | | | | | |
| HVP-01-29 | 6.54±0.01 | 6.01±0.03 (8.10) | 5.72±0.02 (12.53) | 5.30±0.03 (18.96) | 0.03 |
| Azad | 7.11±0.01 | 6.85±0.01 (3.65) | 6.50±0.03 (8.57) | 6.00±0.03 (15.60) | 0.04 |
| NDVP-08 | 6.98±0.02 | 6.55±0.02 (6.16) | 6.12±0.01 (12.30) | 5.86±0.01 (6.04) | 0.08 |
| **CD (<0.05)** | 0.04 | 5.3 | 0.04 | 0.03 | |
| **CD (<0.05):** | | | | | |
| HVP-01-29 | 0.04 | 0.03 | 0.04 | 0.03 | |
| Azad | 0.03 | 0.04 | 0.04 | 0.04 | |
| NDVP-08 | 0.03 | 0.04 | 0.02 | 0.03 | |

Values are mean ± SE three independent determination

Figures in parenthesis indicate percent change compared to zero day

Total soluble sugar content in sun dried peas ranged from 5.13 to 6.96 g/100g in various varieties throughout the storage period. There was significant decline of 5.17 to 19.08 per cent during different intervals of storage. Difference in total soluble sugar content of various sun dried varieties was recorded which was statistically significant. Azad contained maximum total soluble sugar content followed by NDVP-08 and HVP-01-29 variety. The trend remained same among the various varieties during storage.

Total soluble sugar content in oven dried peas varied from 5.30 to 7.11 g/100g in various varieties throughout the storage period. Significant decline (3.65ï 18.96%) was observed during 0, $30^{th}$, $60^{th}$ and $90^{th}$ day of storage. Significant difference in total soluble sugar content was observed in various oven dried varieties. It was found that Azad variety contained highest total soluble sugar content followed by NDVP-08 and HVP-01-29 variety. Similar trend was observed among various varieties during the storage. The value of total soluble sugar ranged from 4.60 to 10.14 percent in dehydrated peas during storage of 2 months (Ruchika, 2004). Sheriful (2002) also reported a decline of 0.85 to 1.23 percent in total soluble sugar content of various dehydrated cultivars of peas throughout the storage of 6 months.

Significant difference was noticed in total soluble sugar content of variety HVP-01-29 during all the treatment of variety HVP-01-29 during all the treatments and storage period. Similarly, significant differences were observed for the other varieties (Azad and NDVP-08) for all the treatments and storage.

**Reducing sugar:** Reducing sugar content (Table 4.35) of frozen peas varied from 0.54 to 1.10 g/100g in various varieties throughout the storage. Significant decrease of 3.63 ï 21.73 per cent was noticed during different intervals of storage. There was significant difference in the reducing sugar content of various frozen varieties. It was observed that Azad contained maximum reducing sugar content followed by NDVP-08 and HVP-01-29 variety. Similar trend was observed among the various varieties throughout the storage.

Reducing sugar content in sun dried peas ranged from 1.32 to 1.57 g/100g in various varieties during the storage. Decline of 5.73 to 23.72 per cent was observed during 0, $30^{th}$, $60^{th}$ and $90^{th}$ day of storage, which was statistically significant. Significant difference in reducing sugar content of various sun dried varieties was observed. Azad contained maximum reducing sugar followed by NDVP-08 and HVP-01-29 variety. Same trend was noticed among the various varieties throughout storage.

Reducing sugar content in oven dried peas ranged from 1.31 to 1.54 g/100g among various varieties during storage. There was significant decline (5.84 -23.00%) in reducing sugar content during 0, $30^{th}$, $60^{th}$ and $90^{th}$ day of storage. Significant difference was observed in various oven dried varieties. Azad was found to have highest reducing sugar content followed by NDVP-08 and HVP-01-29 varieties. Similar trend was observed among the various varieties throughout the storage.

Significant difference was noticed in the reducing sugar content of variety HVP-01-29 during all the treatments and storage. Similarly, significant differences were observed for other varieties i.e. Azad and

**Table 4.35 : Effect of storage on reducing sugar content (g/100g, dry matter basis) of frozen and dried pea varieties**

| Variety | Storage period (days) | | | | |
|---|---|---|---|---|---|
| **Freezing** | **0** | **30** | **60** | **90** | **CD (<0.05)** |
| HVP-01-29 | 0.69±0.01 | 0.63±0.01 (8.69) | 0.59±0.01 (14.49) | 0.54±0.01 (21.73) | 0.04 |
| Azad | 1.10±0.02 | 1.06±0.03 (3.63) | 1.01±0.03 (8.18) | 0.97±0.31 (11.81) | 0.03 |
| NDVP-08 | 0.83±0.01 | 0.79±0.01 (4.81) | 0.74±0.02 (10.84) | 0.70±0.01 (15.66) | 0.03 |
| **CD (<0.05)** | 0.04 | 0.05 | 0.03 | 0.07 | |
| **Sun drying** | | | | | |
| HVP-01-29 | 1.18±0.01 | 1.09±0.01 (7.62) | 0.99±0.01 (16.10) | 0.90±0.01 (23.72) | 0.05 |
| Azad | 1.57±0.02 | 1.48±0.04 (5.73) | 1.40±0.02 (10.82) | 1.32±0.03 (15.92) | 0.04 |
| NDVP-08 | 1.30±0.03 | 1.20±0.03 (7.69) | 1.11±0.05 (14.60) | 1.03±0.02 (20.76) | 0.06 |
| **CD (<0.05)** | 0.05 | 0.04 | 0.04 | 0.04 | |
| **Oven drying** | | | | | |
| HVP-01-29 | 1.13±0.07 | 1.01±0.02 (10.61) | 0.94±0.01 (16.81) | 0.87±0.00 (23.00) | 0.06 |
| Azad | 1.54±0.01 | 1.45±0.03 (5.84) | 1.39±0.03 (9.74) | 1.31±0.03 (14.93) | 0.03 |
| NDVP-08 | 1.26±0.01 | 1.16±0.01 (7.93) | 1.11±0.01 (11.90) | 1.02±0.02 (19.06) | 0.04 |
| **CD (<0.05)** | 0.15 | 0.05 | 0.05 | 0.02 | |
| **CD (<0.05) :** | | | | | |
| HVP-01-29 | 0.06 | 0.04 | 0.05 | 0.04 | |
| Azad | 0.05 | 0.03 | 0.03 | 0.05 | |
| NDVP-08 | 0.03 | 0.04 | 0.03 | 0.03 | |

Values are mean ± SE three independent determination

Figures in parenthesis indicate percent change compared to zero day

NDVP-08 varieties for all treatments and storage period. Reducing sugar content was almost similar in sun dried and oven dried peas till the end of storage period.

**Non-reducing sugar:** Non-reducing sugar in frozen peas varied from 7.32 to 7.90 g/100g in various varieties during the storage period. Significant decrease 1.28 to 4.18 per cent (Table 4.36) was noticed during different intervals of storage. There was significant difference in non-reducing sugar content of various frozen varieties. It was observed that Azad contained highest non-reducing sugar followed by NDVP-08 and HVP-01-29 variety. Similar trend was observed among various varieties during storage.

Non-reducing sugar content in sun dried peas varied from 5.16 to 6.72 g/100g during storage in various varieties. Significant decrease (6.34 ï 2012%) was observed during different intervals of storage. Significant difference in non-reducing sugar content of various sun dried varieties was noticed. Azad was found to contain maximum non-reducing sugar content followed by NDVP-08 and HVP-01-29 variety. The trend remained the same among the various varieties throughout the storage.

Non-reducing sugar content in oven dried peas ranged from 5.32 to 6.87 g/100g during storage in various varieties. Significant decrease of 8.30 to 19.51 per cent was estimated during different intervals of storage. Significant difference in non-reducing sugar content of various oven dried varieties was observed. Highest reducing sugar was recorded in Azad variety followed by NDVP-08 and HVP-01-29 variety. The similar trend was observed among the various varieties during storage.

**Table 4.36 : Effect of storage on non-reducing sugar content (g/100g, dry matter basis) of frozen and dried pea varieties**

| Variety | Storage period (days) | | | | |
|---|---|---|---|---|---|
| **Freezing** | **0** | **30** | **60** | **90** | **CD (<0.05)** |
| HVP-01-29 | 7.64±0.01 | 7.53±0.01 (1.43) | 7.42±0.02 (2.87) | 7.32±0.01 (4.18) | 0.04 |
| Azad | 7.90±0.03 | 7.79±0.34 (1.39 | 7.69±0.32 (2.65) | 7.61±0.01 (3.67) | 0.05 |
| NDVP-08 | 7.77±0.01 | 7.67±0.02 (1.28 | 7.57±0.01 (2.57) | 7.47±0.00 (3.86) | 0.09 |
| **CD (<0.05)** | 0.04 | 0.08 | 0.07 | 0.04 | |
| **Sun drying** | | | | | |
| HVP-01-29 | 6.46±0.02 | 6.05±0.01 (6.34) | 5.60±0.04 (13.31) | 5.16±0.04 (20.12) | 0.03 |
| Azad | 6.72±0.01 | 6.21±0.02 (7.58) | 5.83±0.00 (13.24) | 5.47±0.01 (18.60) | 0.05 |
| NDVP-08 | 6.59±0.03 | 6.17±0.02 (6.37) | 5.73±0.01 (13.05) | 5.32±0.01 (19.27) | 0.04 |
| **CD (<0.05)** | 0.03 | 0.06 | 0.04 | 0.04 | |
| **Oven drying** | | | | | |
| HVP-01-29 | 6.61±0.01 | 6.06±0.02 (8.32) | 5.62±0.02 (14.97) | 5.32±0.01 (19.51) | 0.04 |
| Azad | 6.87±0.01 | 6.22±0.03 (9.46) | 5.85±0.03 (14.84) | 5.64±0.03 (17.90) | 0.02 |
| NDVP-08 | 6.74±0.02 8.30 | 6.18±0.01 (8.30) | 5.76±0.01 (14.54) | 5.49±0.01 (18.54) | 0.09 |
| **CD (<0.05)** | 0.04 | 0.03 | 0.03 | 0.04 | |
| **CD (<0.05) :** | | | | | |
| HVP-01-29 | 0.06 | 0.04 | 0.02 | 0.04 | |
| Azad | 0.04 | 0.05 | 0.06 | 0.04 | |
| NDVP-08 | 0.03 | 0.04 | 0.04 | 0.03 | |

Values are mean ± SE three independent determination

Figures in parenthesis indicate percent change compared to zero day

Significant difference was noticed in the non-reducing sugar content of variety HVP-01-29 during all the treatments and storage. Similarly, significant difference in non-reducing sugar content was noticed for the other two varieties i.e. Azad and NDVP-08 throughout the storage period. Non reducing sugar content was almost similar in sun dried and oven dried peas till the end of storage period.

***In vitro* protein digestibility:** *In vitro* protein digestibility (Table 4.37) in frozen peas ranged from 66.10 to 70.96 per cent in various varieties during the storage period. Significant decrease of 0.35 to 3.67 per cent was observed during 0, $30^{th}$, $60^{th}$ and $90^{th}$ day of storage. Significant difference in *in vitro* protein digestibility of various frozen varieties was observed. Azad variety was found to contain maximum *in vitro* protein digestibility followed by NDVP-08 and HVP-01-29 variety. Similar trend was observed among the various varieties during storage.

*In vitro* protein digestibility in sun dried peas varied from 69.15 to 75.01 per cent in various varieties throughout the storage. Significant decline of 0.49 to 5.33 per cent was noticed during different intervals of storage. Difference in *in vitro* protein digestibility of various sun dried varieties was noticed which was statistically significant. It was found that Azad variety contained the highest *in vitro* protein digestibility followed by NDVP-08 and HVP-01-29 variety. Same trend was noticed among the various varieties throughout the storage.

*In vitro* protein digestibility in oven dried peas ranged from 69.69 to 76.06 per cent in various varieties during the storage. Decline i.e. 1.58 to 6.67 per cent was observed during different intervals of storage. The

**Table 4.37 : Effect of storage on *in vitro protein* digestibility (%, dry matter basis) of frozen and dried pea varieties**

| Variety | Storage period (days) | | | | |
|---|---|---|---|---|---|
| **Freezing** | **0** | **30** | **60** | **90** | **CD (<0.05)** |
| HVP-01-29 | 69.24±0.04 | 68.12±0.02 (1.61) | 67.95±0.01 (1.86) | 66.10±0.03 (3.66) | 0.08 |
| Azad | 70.96±0.02 | 69.98±0.03 (1.38) | 68.96±0.01 (2.81) | 68.40±0.01 (3.60) | 0.04 |
| NDVP-08 | 70.16±0.01 | 69.91±0.01 (0.35) | 68.95±0.02 (1.72) | 67.58±0.02 (3.67) | 0.06 |
| **CD (<0.05)** | 0.09 | 0.05 | 0.05 | 0.04 | |
| **Sun drying** | | | | | |
| HVP-01-29 | 73.05±0.01 | 72.13±0.02 (1.25) | 71.20±0.01 (3.53) | 69.15±0.01 (5.33) | 0.05 |
| Azad | 75.01±0.02 | 73.91±0.01 (1.46) | 72.94±0.03 (3.86) | 71.41±0.02 (4.79) | 0.05 |
| NDVP-08 | 74.30±0.03 | 73.95±0.01 (0.49) | 72.83±0.01 (2.90) | 70.55±0.03 (5.04) | 0.06 |
| **CD (<0.05)** | 0.05 | 0.40 | 0.03 | 0.04 | |
| **Oven drying** | | | | | |
| HVP-01-29 | 72.92±0.03 | 71.82±0.06 (1.52) | 70.34±0.03 (3.53) | 68.05±0.01 (6.67) | 0.03 |
| Azad | 76.06±0.01 | 74.32±0.03 (2.28) | 73.12±0.02 (3.86) | 71.36±0.03 (6.17) | 0.09 |
| NDVP-08 | 74.40±0.01 | 73.15±0.02 (1.68) | 72.24±0.01 (2.90) | 69.69±0.02 (6.45) | 0.08 |
| **CD (<0.05)** | 0.04 | 0.42 | 0.05 | 0.09 | |
| **CD (<0.05):** | | | | | |
| HVP-01-29 | 0.03 | 0.05 | 0.04 | 0.03 | |
| Azad | 0.04 | 0.07 | 0.05 | 0.09 | |
| NDVP-08 | 0.05 | 0.03 | 0.04 | 0.05 | |

Values are mean ± SE three independent determination

Figures in parenthesis indicate percent change compared to zero day

decline was statistically significant. Significant difference in *in vitro* protein digestibility of various oven dried varieties was observed. Azad variety was found to contain maximum *in vitro* protein digestibility followed by NDVP-08 and HVP-01-29 variety. The trend remained same among the various varieties during storage.

Significant difference was observed in the *in vitro* protein digestibility of variety HVP-01-29 during all the treatments and storage period. Similarly significant differences in *in vitro* protein digestibility were observed for other two varieties during all the treatments and storage.

***In vitro* starch digestibility:** *In vitro* starch digestibility in frozen peas varied from 37.30 to 40.99 mg/100g in various varieties during the storage period. Significant decrease of 2.63 to 7.35 per cent (Table 4.38) was noticed during 0, $30^{th}$, $60^{th}$ and $90^{th}$ day of storage. Difference in *in vitro* starch digestibility of various frozen varieties was noticed and the difference was significant. It was found that Azad variety contained maximum *in vitro* starch digestibility followed by HVP-01-29 and NDVP-08 variety. The same trend was noticed among the various varieties during storage. Similar decline in *in vitro* starch digestibility of frozen baby corn has been observed during storage of 3 months (Santosh, 2005).

*In vitro* starch digestibility in sun dried peas ranged from 38.66 to 42.25 mg/100g in various varieties throughout the storage period. Significant decline i.e. 2.76 to 9.25 per cent was noticed during different intervals of storage. Significant difference in *in vitro* starch digestibility

**Table 4.38 : Effect of storage on *in vitro starch* digestibility (mg/100g, dry matter basis) of frozen and dried pea varieties**

| Variety | Storage period (days) | | | | |
|---|---|---|---|---|---|
| **Freezing** | **0** | **30** | **60** | **90** | **CD (<0.05)** |
| HVP-01-29 | 40.26±0.02 | 39.20±0.04 (2.63) | 38.51±0.03 (4.34) | 37.30±0.03 (7.35) | 0.03 |
| Azad | 40.99±0.03 | 39.25±0.01 (4.24) | 38.52±0.01 (6.02) | 38.09±0.01 (7.07) | 0.04 |
| NDVP-08 | 39.90±0.02 | 38.23±0.03 (4.18) | 37.56±0.02 (5.86) | 36.97±0.04 (7.34) | 0.05 |
| **CD (<0.05)** | 0.04 | 0.06 | 0.04 | 0.04 | |
| **Sun drying** | | | | | |
| HVP-01-29 | 42.60±0.01 | 41.01±0.01 (3.73) | 40.93±0.02 (3.92) | 38.66±0.01 (9.24) | 0.04 |
| Azad | 43.55±0.02 | 42.12±0.01 (2.83) | 41.96±0.03 (3.20) | 39.46±0.02 (8.97) | 0.07 |
| NDVP-08 | 42.25±0.01 | 41.08±0.05 (2.76) | 40.94±0.01 (3.10) | 38.34±0.02 (9.25) | 0.05 |
| **CD (<0.05)** | 0.06 | 0.06 | 0.04 | 0.07 | |
| **Oven drying** | | | | | |
| HVP-01-29 | 42.49±0.01 | 41.04±0.03 (3.41) | 40.96±0.02 (3.60) | 38.55±0.02 (9.27) | 0.04 |
| Azad | 43.22±0.01 | 42.15±0.01 (2.47) | 41.98±0.02 (2.86) | 39.42±0.01 (8.79) | 0.05 |
| NDVP-08 | 42.13±0.02 | 41.12±0.02 (2.39) | 40.96±0.01 (2.77) | 38.24±0.01 (9.23) | 0.06 |
| **CD (<0.05)** | 0.05 | 0.05 | 0.05 | 0.05 | |
| **CD (<0.05) :** | | | | | |
| HVP-01-29 | 0.04 | 0.04 | 0.03 | 0.05 | |
| Azad | 0.05 | 0.05 | 0.08 | 0.06 | |
| NDVP-08 | 0.06 | 0.04 | 0.03 | 0.05 | |

Values are mean ± SE three independent determination

Figures in parenthesis indicate percent change compared to zero day

of various sun dried varieties was observed. Highest *in vitro* starch digestibility was recorded in Azad variety followed by HVP-01-29 variety. Similar trend was observed among various varieties throughout the storage.

*In vitro* starch digestibility in oven dried varieties varied from 38.55 to 43.22 mg/100g in various varieties during the storage period. Decline of 2.39 to 9.27 per cent was recorded during 0, $30^{th}$, $60^{th}$ and $90^{th}$ day of storage and the decline was statistically significant. Significant difference in *in vitro* starch digestibility of various oven dried varieties was recorded. Azad variety was found to be maximum followed by HVP-01-29 and NDVP-08 variety. The trend remained similar in various varieties during storage. Also slight decrease of 6.35 percent has been noted in *in vitro* starch digestibility of dehydrated and stored baby corn by Santosh (2005).

Difference in *in vitro* starch digestibility of variety HVP-01-29 during all the treatments and storage period was recorded and difference was significant. Similarly significant difference in *in vitro* starch digestibility was recorded for other two varieties (Azad and NDVP-08) during all the treatments (freezing, sun drying and oven drying) and storage. *In vitro* protein and starch digestibility decreased during storage as antinutrients increased till the end of storage period because antinutrients adversely affect protein and starch digestibility.

## Minerals

**Iron:** iron content ranged in frozen peas from 10.76 to 13.75 mg/100g (Table 4.39) various varieties during the storage period. Significant decline of 0.43 to 2.03 per cent was estimated during 0, 30$^{th}$, 60$^{th}$ and 90$^{th}$ day of storage. Difference in iron content of various frozen varieties was recorded that was significant. Iron content was found to be maximum in Azad variety followed by NDVP-08 and HVP-01-29 variety. The similar trend was observed in various varieties during storage. Santosh (2005) reported higher decrease (4.38 to 8.77%) in iron content of frozen baby corn during storage of three months.

Iron content sun dried peas varied from 10.47 to 13.07 mg/100g in various varieties throughout the storage period. Decline of 0.49 to 3.23 per cent was observed during 0, 30$^{th}$, 60$^{th}$ and 90$^{th}$ day of storage. The decline was statically significant. Significant difference in iron content of various sun dried varieties was recorded. Azad variety contained maximum iron content followed by NDVP-08 and HVP-01-29 variety. The trend remained same throughout the storage period in various varieties.

Iron content in oven dried peas ranged from 10.97 to 13.27 mg/100g in various varieties during the storage period. Significant decline (0.75 to 3.00%) was estimated during 0, 30$^{th}$, 60$^{th}$ and 90$^{th}$ day of storage. Significant difference in iron content of various oven dried varieties was observed. Highest iron content was observed in Azad variety followed by NDVP-08 and HVP-01-29 variety. Similar trend was noticed in various varieties during the storage period. Iron content declined from 6.91 to 6.57 mg/100g during the storage of baby corn for duration of 3 months as reported by Santosh (2005)

**Table 4.39 : Effect of storage on iron content (mg/100g, dry matter basis) of frozen and dried pea varieties**

| Variety | Storage period (days) | | | | |
|---|---|---|---|---|---|
| **Freezing** | **0** | **30** | **60** | **90** | **CD (<0.05)** |
| HVP-01-29 | 11.75±0.01 | 11.69±0.04 (0.67) | 11.60±0.02 (1.44) | 10.76±0.01 (2.03) | 0.04 |
| Azad | 13.75±0.02 | 13.65±0.01 (0.43) | 13.59±0.01 (0.87) | 12.88±0.03 (1.45) | 0.05 |
| NDVP-08 | 12.68±0.03 | 12.60±0.02 (0.63) | 12.52±0.03 (1.26) | 11.70±0.02 (1.10) | 0.06 |
| **CD (<0.05)** | 0.05 | 0.07 | 0.04 | 0.04 | |
| **Sun drying** | | | | | |
| HVP-01-29 | 11.14±0.00 | 11.01±0.01 (1.16) | 10.89±0.00 (2.24) | 10.41±0.02 (3.23) | 0.04 |
| Azad | 13.07±0.01 | 12.98±0.00 (0.68) | 12.88±0.01 (0.68) | 13.33±0.01 (2.44) | 0.04 |
| NDVP-08 | 12.04±0.01 | 11.98±0.03 (0.49) | 11.86±0.00 (1.49) | 12.45±0.00 (2.82) | 0.05 |
| **CD (<0.05)** | 0.04 | 0.03 | 0.03 | 0.05 | |
| **Oven drying** | | | | | |
| HVP-01-29 | 11.31±0.01 | 11.20±0.01 (0.97) | 11.06±0.00 (2.21) | 10.97±0.03 (3.00) | 0.04 |
| Azad | 13.27±0.04 | 13.17±0.03 (0.75) | 13.05±0.01 (1.65) | 12.97±0.02 (2.26) | 0.04 |
| NDVP-08 | 12.22±0.00 | 12.12±0.02 (0.81) | 12.01±0.03 (1.71) | 11.90±0.00 (2.61) | 0.05 |
| **CD (<0.05)** | 0.05 | 0.06 | 0.03 | 0.03 | |
| **CD (<0.05) :** | | | | | |
| HVP-01-29 | 0.04 | 0.04 | 0.02 | 0.06 | |
| Azad | 0.05 | 0.04 | 0.04 | 0.05 | |
| NDVP-08 | 0.05 | 0.03 | 0.03 | 0.02 | |

Values are mean ± SE three independent determination

Figures in parenthesis indicate percent change compared to zero day

Significant difference was noticed in iron content of variety HVP-01-29 during all the treatments and storage. Similarly significant difference in iron content was recorded for other varieties i.e. Azad and NDVP-08 during all the treatments and storage.

In an another study decline of 1.30 to 4.92 per cent was estimated during the storage of dried baby corn for a period of 3 months (Santosh, 2005).

**Zinc:** Zinc content in frozen peas ranged from 4.33 to 5.24 per cent Table 4.40) in various varieties throughout the storage period. A decline of 0.82 to 5.66 per cent was observed during 0, $30^{th}$, $60^{th}$ and $90^{th}$ day of storage and the decline was significant. Significant difference in zinc content of various frozen varieties was estimated. Highest zinc content was observed in Azad variety followed by NDVP-08 and HVP-01-29 variety. Similar trend was observed in various varieties during the storage period.

Zinc content in sun dried peas ranged from 3.58 to 4.65 per cent in various varieties during the storage period. Significant decline of 2.15 to 10.05 per cent was estimated during different intervals of storage. Significant difference in zinc content of various sun dried varieties was recorded. Zinc content was found to be maximum in Azad variety followed by NDVP-08 and HVP-01-29 variety. Same trend was noticed in various varieties during storage.

Zinc content in oven dried peas varied from 3.73 to 4.77 in various varieties during the storage period. Significant decline of 2.52 to 9.46 per cent was observed during different intervals of storage. Significant

**Table 4.40 : Effect of storage on zinc content (mg/100g, dry matter basis) of frozen and dried pea varieties**

| Variety | Storage period (days) | | | | |
|---|---|---|---|---|---|
| **Freezing** | **0** | **30** | **60** | **90** | **CD (<0.05)** |
| HVP-01-29 | 4.59±0.02 | 4.50±0.01 (1.96) | 4.40±0.00 (4.23) | 4.33±0.01 (5.66) | 0.04 |
| Azad | 4.24±0.01 | 5.16±0.02 (1.52) | 5.10±0.02 (2.67) | 5.02±0.03 (4.190 | 0.04 |
| NDVP-08 | 4.82±0.01 | 4.78±0.00 (0.82) | 4.65±0.01 (3.52) | 4.58±0.02 (4.97) | 0.06 |
| **CD (<0.05)** | 0.05 | 0.05 | 0.04 | 0.05 | |
| **Sun drying** | | | | | |
| HVP-01-29 | 3.98±0.00 | 3.92±0.01 (3.01) | 3.75±0.01 (5.77) | 3.58±0.02 (10.05) | 0.05 |
| Azad | 4.65±0.01 | 4.48±0.03 (2.15) | 4.42±0.00 (4.94) | 4.29±0.01 (7.74) | 0.03 |
| NDVP-08 | 4.21±0.01 | 3.99±0.02 (2.61) | 3.98±0.03 (5.46) | 3.82±0.01 (9.26) | 0.05 |
| **CD (<0.05)** | 0.46 | 0.03 | 0.08 | 0.05 | |
| **Oven drying** | | | | | |
| HVP-01-29 | 4.12±0.04 | 4.01±0.04 (2.66) | 3.93±0.02 (4.61) | 3.73±0.01 (9.46) | 0.04 |
| Azad | 4.77±0.01 | 4.63±0.01 (2.93) | 4.54±0.01 (4.82) | 4.39±0.34 (7.96) | 0.10 |
| NDVP-08 | 4.35±0.02 | 4.24±0.02 (2.52) | 4.12±0.00 (4.13) | 3.99±0.01 (8.27) | 0.09 |
| **CD (<0.05)** | 0.03 | 0.05 | 0.05 | 0.09 | |
| **CD (<0.05) :** | | | | | |
| HVP-01-29 | 0.04 | 0.05 | 0.05 | 0.06 | |
| Azad | 0.03 | 0.06 | 0.03 | 0.09 | |
| NDVP-08 | 0.04 | 0.04 | 0.08 | 0.06 | |

Values are mean ± SE three independent determination

Figures in parenthesis indicate percent change compared to zero day

difference in zinc content of various oven dried varieties was recorded. Zinc content was found to be maximum in Azad variety followed by NDVP-08 and HVP-01-29 variety. Similar trend was observed in various varieties during storage.

Difference in zinc content of variety HVP-01-29 during all the treatments and storage was observed and difference was found to be significant. Similarly, significant differences in zinc content were recorded for other varieties i.e. Azad and NDVP-08 during all the treatments and storage.

**Calcium:** Calcium content in frozen peas ranged from 27.49 to 30.1 mg/100g in various varieties during the storage (Table 4.41). Significant decline, which ranged from 0.71 to 2.21 per cent, was estimated on 0, $30^{th}$, $60^{th}$ and $90^{th}$ day of storage. Calcium content differed significantly in various frozen varieties. Highest calcium content was observed in Azad variety followed by HVP-01-29 and NDVP-08 variety. Same trend was noticed in various varieties during storage.

Calcium content in sun dried peas varied from 23.33 to 26.89 mg/100g in various varieties throughout storage period. Significant decline of 0.93 to 6.15 per cent was noticed on 0, $30^{th}$, $60^{th}$ and $90^{th}$ day of storage. There was significant difference in the calcium content of various varieties. Azad variety was found to contain maximum calcium content followed by HVP-01-29 and NDVP-08. The trend remained similar in various varieties during storage.

**Table 4.41 : Effect of storage on calcium content (mg/100g, dry matter basis) of frozen and dried pea varieties**

| Variety | Storage period (days) | | | | |
|---|---|---|---|---|---|
| **Freezing** | **0** | **30** | **60** | **90** | **CD (<0.05)** |
| HVP-01-29 | 28.95±0.00 | 28.14±0.02 (0.72) | 28.52±0.01 (1.48) | 28.31±0.00 (2.21) | 0.02 |
| Azad | 30.12±0.01 | 29.90±0.00 (0.73) | 29.71±0.01 (1.36) | 29.52±0.01 (1.99) | 0.04 |
| NDVP-08 | 28.11±0.01 | 27.91±0.03 (0.71) | 27.75±0.02 (2.17) | 27.49±0.02 (1.28) | 0.05 |
| **CD (<0.05)** | 0.04 | 0.02 | 0.04 | 0.05 | |
| **Sun drying** | | | | | |
| HVP-01-29 | 25.74±0.01 | 25.50±0.01 (0.93) | 25.26±0.02 (1.86) | 24.14±0.01 (6.02) | 0.05 |
| Azad | 26.89±0.02 | 26.42±0.01 (1.74) | 26.01±0.01 (3.27) | 25.38±0.00 (5.61) | 0.04 |
| NDVP-08 | 24.86±0.02 | 24.44±0.00 (1.68) | 24.97±0.01 (3.58) | 23.33±0.02 (6.15) | 0.06 |
| **CD (<0.05)** | 0.06 | 0.03 | 0.07 | 0.03 | |
| **Oven drying** | | | | | |
| HVP-01-29 | 27.75±0.01 | 27.35±0.01 (1.44) | 27.01±0.02 (2.66) | 26.22±0.02 (5.51) | 0.05 |
| Azad | 28.89±0.02 | 28.41±0.00 (1.66) | 28.06±0.01 (2.87) | 27.39±0.00 (5.19) | 0.02 |
| NDVP-08 | 26.87±0.01 | 26.32±0.02 (2.04) | 26.03±0.03 (3.12) | 25.36±0.01 (5.61) | 0.07 |
| **CD (<0.05)** | 0.04 | 0.03 | 0.05 | 0.04 | |
| **CD (<0.05):** | | | | | |
| HVP-01-29 | 0.03 | 0.03 | 0.07 | 0.05 | |
| Azad | 0.05 | 0.02 | 0.05 | 0.03 | |
| NDVP-08 | 0.06 | 0.02 | 0.03 | 0.05 | |

Values are mean ± SE three independent determination

Figures in parenthesis indicate percent change compared to zero day

Calcium content in oven dried peas ranged from 25.36 to 28.89 mg/100g in various varieties during the storage. Decline of 1.44 to 5.61 per cent was observed on different intervals of storage, which was statistically significant. Significant difference in calcium content was recorded in various frozen varieties. It was found that Azad variety contained the highest calcium content followed by HVP-01-29 and NDVP-08 variety.

Significant difference in calcium content was noticed in calcium content of HVP-01-29 variety during all the treatments (freezing, sun drying and oven drying) and storage. Similarly, significant differences were observed in calcium content for other two varieties i.e. Azad and NDVP-08 during all the treatments and storage.

**Antinutrients**

**Phytic acid:** Phytic acid content in frozen peas varied from 423.00 to 527.16 mg/100g in various varieties during the storage. Non-significant increase (0.82ï 2.60%) was estimated on 0, $30^{th}$, $60^{th}$ and $90^{th}$ day of storage. Phytic acid content differed significantly in various frozen varieties. Highest phytic acid (Table 4.42) content was observed in HVP-01-29 variety followed NDVP-08 and Azad variety. Similar trend was noticed in various varieties during storage.

Phytic acid content in sun dried ranged from 380.07 to 440.60 mg/100g in various varieties throughout the storage. Increase of 1.49 to 6.05 per cent was estimated on different intervals of storage. The increase was observed to be significant. There was significant difference

**Table 4.42 : Effect of storage on phytic acid content (mg/100g, dry matter basis) of frozen and dried pea varieties**

| Variety | Storage period (days) | | | | |
|---|---|---|---|---|---|
| **Freezing** | **0** | **30** | **60** | **90** | **CD (<0.05)** |
| HVP-01-29 | 515.16±0.05 | 520.11±0.01 (0.96) | 524.00±0.01 (1.71) | 527.16±0.00 (2.32) | NS |
| Azad | 482.08±0.01 | 486.07±0.02 (0.82) | 488.02±0.01 (1.23) | 492.06±0.01 (2.07) | NS |
| NDVP-08 | 423.00±0.01 | 427.33±0.01 (7.02) | 431.26±0.02 (1.95) | 434.00±0.01 (2.60) | NS |
| **CD (<0.05)** | 0.11 | 0.07 | 0.06 | 0.04 | |
| **Sun drying** | | | | | |
| HVP-01-29 | 410.13±0.01 | 418.21±0.02 (1.97) | 426.10±0.00 (3.89) | 433.11±0.01 (5.60) | 0.05 |
| Azad | 380.07±0.00 | 387.01±0.01 (1.82) | 395.11±0.01 (3.95) | 403.08±0.03 (6.05) | 0.06 |
| NDVP-08 | 419.00±0.01 | 425.28±0.02 (1.49) | 433.89±0.00 (3.55) | 440.60±0.02 (5.01) | 0.04 |
| **CD (<0.05)** | 0.15 | 0.17 | 0.03 | 0.03 | |
| **Oven drying** | | | | | |
| HVP-01-29 | 407.10±0.01 | 414.00±0.00 (1.69) | 421.02±0.01 (3.41) | 429.11 ±0.02 (5.04) | 0.03 |
| Azad | 378.06±0.01 | 384.01±0.01 (1.57) | 391.20±0.02 (3.47) | 397.20±0.03 (5.02) | 0.05 |
| NDVP-08 | 416.50±0.01 | 422.43±0.02 (1.42) | 429.63±0.01 (3.15) | 436.52±0.01 (4.80) | 0.04 |
| **CD (<0.05)** | 0.04 | 0.06 | 0.05 | 0.02 | |
| **CD (<0.05):** | | | | | |
| HVP-01-29 | 0.05 | 0.05 | 0.04 | 0.03 | |
| Azad | 0.04 | 0.04 | 0.05 | 0.03 | |
| NDVP-08 | 0.04 | 0.07 | 0.05 | 0.03 | |

Values are mean ± SE three independent determination

Figures in parenthesis indicate percent change compared to zero day

in phytic acid content of various sun dried varieties. It was found that NDVP-08 variety contained highest phytic acid content followed by HVP-01-29 and Azad variety. Same trend was recorded in various varieties throughout storage.

Phytic acid content in oven dried varied from 378.06 to 436.52 mg/100g in various varieties during the storage. Significant increase i.e. 1.42 to 5.04 per cent was noticed during different intervals of storage. There was significant difference in phytic acid content of various oven dried varieties. NDVP-08 variety was found to contain maximum phytic acid content followed by HVP-01-29 and Azad variety.

Significant difference in phytic acid content of variety HVP-01-29 during all the treatments and storage was noticed. Similarly, significant differences were observed for other varieties i.e. Azad and NDVP-08 for all treatments and storage period. Phytic acid content was almost similar in sun dried and oven dried peas during storage.

**Polyphenol :** Polyphenol content in frozen varieties varied from 852.00 to 926.21 mg/100g in various varieties during the storage (Table 4.43). Non-significant increase of 0.50 to 1.78 per cent was noticed on different intervals of storage. There was significant difference in polyphenol content of various frozen varieties. HVP-01-29 variety was found to contain maximum polyphenol content followed by NDVP-08 and Azad variety. The trend remained similar in various varieties during storage.

Polyphenol content in sun dried peas ranged from 530.00 to 604.12 mg/100g in various varieties throughout the storage. Increase of 1.15 to

**Table 4.43 : Effect of storage on polyphenol content (mg/100g, dry matter basis) of frozen and dried pea varieties**

| Variety | Storage period (days) | | | | |
|---|---|---|---|---|---|
| **Freezing** | **0** | **30** | **60** | **90** | **CD (<0.05)** |
| HVP-01-29 | 910.00±0.00 | 915.11±0.02 (0.56) | 920.21±0.03 (1.12) | 926.21±0.01 (1.78) | NS |
| Azad | 852.00±0.01 | 856.30±0.03 (0.50) | 859.12±0.02 (0.83) | 862.01±0.02 (1.17) | NS |
| NDVP-08 | 885.00±0.02 | 890.31±0.02 (0.60) | 894.22±0.01 (1.04) | 897.11±0.01 (1.36) | NS |
| **CD (<0.05)** | 0.06 | 0.07 | 0.06 | 0.05 | |
| **Sun drying** | | | | | |
| HVP-01-29 | 580.00±0.02 | 587.14±0.01 (1.23) | 596.01±0.01 (2.76) | 604.12±0.01 (4.15) | 0.06 |
| Azad | 530.00±0.00 | 536.10±0.00 (1.15) | 542.02±0.02 (2.26) | 550.23±0.02 (3.81) | 0.03 |
| NDVP-08 | 560.00±0.01 | 568.30±0.03 (1.48) | 579.41±0.01 (3.46) | 582.35±0.00 (3.99) | 0.04 |
| **CD (<0.05)** | 0.05 | 0.04 | 0.04 | 0.04 | |
| **Oven drying** | | | | | |
| HVP-01-29 | 572.00±0.01 | 578.34±0.02 (1.10) | 586.50±0.00 (2.53) | 593.23±0.01 (3.71) | 0.05 |
| Azad | 524.00±0.03 | 530.24±0.02 (1.19) | 537.11±0.01 (2.50) | 543.20±0.02 (3.66) | 0.05 |
| NDVP-08 | 555.00±0.05 | 561.11±0.05 (1.10) | 568.33±0.02 (2.40) | 576.42±0.01 (3.85) | 0.04 |
| **CD (<0.05)** | 0.05 | 0.07 | 0.04 | 0.06 | |
| **CD (<0.05) :** | | | | | |
| HVP-01-29 | 0.03 | 0.06 | 0.03 | 0.04 | |
| Azad | 0.03 | 0.04 | 0.06 | 0.07 | |
| NDVP-08 | 0.04 | 0.06 | 0.05 | 0.04 | |

Values are mean ± SE three independent

Figures in parenthesis indicate percent change compared to zero day

4.15 per cent was estimated on 0, 30$^{th}$, 60$^{th}$ and 90$^{th}$ day of storage, which was statistically significant. Significant difference in polyphenol content was noticed in various frozen varieties. It was found that HVP-01-29 variety contained highest polyphenol content followed by NDVP-08 and Azad variety. Same trend was observed in various varieties during storage.

Polyphenol content in oven dried pea varied from 524.00 to 593.23 mg/100g in various varieties throughout the storage. Significant increase, which varied from 1.10 to 3.75 per cent, was observed on 0, 30$^{th}$, 60$^{th}$ and 90$^{th}$ day of storage. Significant difference was noticed in polyphenol content of various oven dried varieties. Polyphenol content was observed to be maximum in HVP-01-29 variety followed by NDVP-08 and HVP-01-29 variety. The trend remained same in various varieties during storage.

There was significant difference in polyphenol content of variety HVP-01-29 during all the treatments and storage was observed. Similarly significant differences were observed in other two varieties (Azad and NDVP-08) during all the treatments and storage. Polyphenol content was almost similar in sun dried and oven dried peas during storage. Antinutrients adversely affect protein (Hulse, 1991) and starch digestibility (Kataria and Chauhan, 1988).

**Vitamins**

**β-carotene:** ϐ-carotene content (Table 4.44) in frozen peas varied from 64.06 to 73.05 µg/100g in various varieties during the storage. Significant decline (1.04 to 6.01%) was observed on different intervals of storage. Significant difference was noticed in ϐ-carotene content of various frozen

varieties. It was found that ɓ-carotene content was maximum in Azad variety followed by NDVP-08 and HVP-01-29 variety. Similar trend was noticed in various varieties during storage.

In a study higher loss i.e. 37.91 per cent in ɓ-carotene content of non-blanched and frozen hamburg and parsley leaves was observed during frozen storage of nine months by Lisiewska and Kmiecik (1997). Lower losses (0.1 to 1.75%) of ɓ-carotene were observed in *bathua* and fenugreek leaves in the refrigerator for 48 hours (Yadav and Sehgal, 1997).

ɓ-carotene content in sun dried peas ranged from 24.16 to 31.25 µg/100g in various varieties throughout the storage period. Decline (4.22 to 18.26%) was estimated on 0, $30^{th}$, $60^{th}$ and $90^{th}$ day of storage. The decline was found to be statistically significant. There was significant difference in ɓ-carotene content of various sun dried varieties. Azad contained highest amount of ɓ-carotene followed by NDVP-08 and HVP-01-29 variety. Same trend was noticed in various varieties during storage.

ɓ-carotene content in oven dried peas varied from 27.94 to 33.26 µg/100g during the storage period in various varieties. Significant decline of 4.55 to 17.11 per cent was noticed during 0, $30^{th}$, $60^{th}$ and $90^{th}$ day of storage. Significant difference in ɓ-carotene content was observed in various varieties. It was found that Azad variety contained maximum ɓ-carotene content followed by NDVP-08 and HVP-01-29 variety. The same trend was observed in various varieties during storage.

**Table 4.44 : Effect of storage on β-carotene (µg/100g) content of frozen and dried pea varieties**

| Variety | Storage period (days) | | | | |
|---|---|---|---|---|---|
| **Freezing** | **0** | **30** | **60** | **90** | **CD (<0.05)** |
| HVP-01-29 | 68.16±0.01 | 65.95±0.08 (1.04) | 63.18±2.67 (2.90) | 64.06±0.02 (6.01) | 0.08 |
| Azad | 73.05±0.08 | 70.04±0.02 (1.38) | 68.54±0.02 (2.60) | 69.06±0.03 (5.46) | 0.08 |
| NDVP-08 | 69.50±0.02 | 65.61±0.01 (1.28) | 63.06±0.01 (2.23) | 65.45±0.03 (5.82) | 0.06 |
| **CD (<0.05)** | 0.05 | 0.04 | 5.33 | 0.07 | |
| **Sun drying** | | | | | |
| HVP-01-29 | 29.56±0.01 | 28.31±0.03 (4.22) | 26.30±0.01 (11.02) | 24.16±0.01 (18.26) | 0.04 |
| Azad | 31.25±0.02 | 29.22±0.06 (6.49) | 27.40±0.02 (12.32) | 25.90±0.02 (17.12) | 0.06 |
| NDVP-08 | 30.01±0.17 | 28.51±0.01 (4.99) | 26.46±0.08 (11.82) | 24.64±0.00 (17.89) | 0.05 |
| **CD (<0.05)** | 0.04 | 0.03 | 0.05 | 0.05 | |
| **Oven drying** | | | | | |
| HVP-01-29 | 31.50±0.01 | 29.76±0.03 (5.52) | 27.54±0.01 (12.57) | 26.11±0.01 (17.11) | 0.03 |
| Azad | 33.26±0.01 | 31.43±0.01 (5.50) | 27.68±0.01 (10.76) | 27.94±0.01 (15.99) | 0.04 |
| NDVP-08 | 32.02±0.02 | 30.56±0.01 (4.55) | 28.85±0.00 (9.90) | 26.67.0±01 (16.70) | 0.05 |
| **CD (<0.05)** | 0.04 | 0.03 | 0.03 | 0.04 | |
| **CD (<0.05) :** | | | | | |
| HVP-01-29 | 0.04 | 0.02 | 0.04 | 0.05 | |
| Azad | 0.05 | 0.05 | 0.07 | 0.08 | |
| NDVP-08 | 0.02 | 0.04 | 0.03 | 0.02 | |

Values are mean ± SE three independent determination

Figures in parenthesis indicate percent change compared to zero day

The present study is in agreement with the study in which ɓ-carotene content decreased by 37.76 per cent by the end of the three months storage of dehydrated pumpkin (Pawar *et al.* 1985). Similar losses of ɓ-carotene during storage have been reported in dehydrated fenugreek (Patil *et al.* 1978). Mehta and Tomar (1980) also showed loss of ɓ-carotene from 3.08 to 1.90 mg percent in dehydrated papaya pieces after one year of storage. Athan and Taylor (2000) reported that loss of vitamin C during the frozen storage of 12 months of peas was 18%. The observed reduction in ɓ-carotene with storage may be due to oxidative or non-oxidative changes.

Significant difference was estimated in ɓ-carotene content of variety HVP-01-29 during all the treatments and storage period. Similarly, significant differences in ɓ-carotene content were observed for the other two varieties i.e. Azad and NDVP-08 for all the treatments (freezing, sun drying and oven drying) and storage.

**Ascorbic acid:** Ascorbic acid content in frozen peas ranged from 28.30 to 31.21 mg/100g in various varieties during the storage (Table 4.45). Decline of 0.64 to 3.53 per cent was observed in ascorbic acid during different intervals of storage and the decline was found to be statistically significant. Significant difference in ascorbic acid content was noticed in various varieties. Azad variety was found to contain highest ascorbic acid content followed by NDVP-08 and HVP-01-29 variety. Similar trend was noticed in various varieties during storage. Pawar *et al.* (1994) reported higher loss of 10.92 per cent during frozen storage of peas for about 4½ months. Similarly, Burger (1982) also reported that the frozen storage of green peas at $-18^0$C for 12 months resulted in 11.00 per cent loss of ascorbic acid.

**Table 4.45 : Effect of storage on ascorbic acid (mg/100g) content of frozen and dried pea varieties**

| Variety | Storage period (days) | | | | |
|---|---|---|---|---|---|
| **Freezing** | **0** | **30** | **60** | **90** | **CD (<0.05)** |
| HVP-01-29 | 29.34±0.01 | 28.91±0.01 (1.46) | 28.85±0.01 (1.67) | 28.30±0.03 (3.53) | 0.03 |
| Azad | 31.21±0.01 | 31.01±0.18 (0.64) | 30.95±0.04 (0.83) | 30.31±0.02 (2.85) | 0.04 |
| NDVP-08 | 29.62±0.01 | 29.10±0.01 (1.75) | 28.80±0.01 (2.77) | 28.66±0.02 (3.24) | 0.06 |
| **CD (<0.05)** | 0.04 | 0.04 | 0.03 | 0.03 | |
| **Sun drying** | | | | | |
| HVP-01-29 | 42.29±0.02 | 39.10±0.00 (7.54) | 38.11±0.03 (9.88) | 37.05±0.01 (12.39) | 0.04 |
| Azad | 47.55±0.03 | 44.01±0.02 (7.44) | 43.71±0.04 (8.07) | 42.01±0.03 (11.04) | 0.08 |
| NDVP-08 | 35.16±0.01 | 31.14±0.01 (8.58) | 30.12±0.02 (14.33) | 29.01±0.02 (17.34) | 0.0.06 |
| **CD (<0.05)** | 0.03 | 0.07 | 0.05 | 0.04 | |
| **Oven drying** | | | | | |
| HVP-01-29 | 44.29±0.02 | 41.01±0.03 (7.40) | 40.63±0.01 (8.25) | 39.35±0.02 (1.74) | 0.05 |
| Azad | 49.36±0.02 | 46.40±0.01 (5.99) | 45.73±0.00 (7.35) | 44.37±0.00 (10.50) | 0.03 |
| NDVP-08 | 37.16±0.02 | 34.10±0.02 (8.23) | 33.15±0.01 (10.79) | 32.21±0.01 (13.85) | 0.08 |
| **CD (<0.05)** | 0.05 | 0.07 | 0.06 | 0.03 | |
| **CD (<0.05) :** | | | | | |
| HVP-01-29 | 0.03 | 0.05 | 0.06 | 0.04 | |
| Azad | 0.05 | 0.07 | 0.02 | 0.03 | |
| NDVP-08 | 0.05 | 0.04 | 0.06 | 0.03 | |

Values are mean ± SE three independent determination

Figures in parenthesis indicate percent change compared to zero day

Ascorbic acid content in sun-dried pea varied from 29.06 to 47.55 per cent in various varieties during the storage. Significant decline of 7.44 to 14.70 per cent observed on 0, $30^{th}$, $60^{th}$ and $90^{th}$ day of storage. Difference was noticed in ascorbic acid content of various varieties, which was statistically significant. It was found that Azad variety contained highest ascorbic acid content followed by HVP-01-29 and NDVP-08 variety. Same trend was noticed in various varieties during storage.

Ascorbic acid content in oven dried peas varied from 32.21 to 49.36 mg/100g during storage in various varieties. Decline (5.99 to 13.85%) was observed on 0, $30^{th}$, $60^{th}$ and $90^{th}$ day of storage and decline was found to be significant. Significant difference in ascorbic content was noticed in various varieties. Azad variety contained maximum ascorbic acid followed y HVP-01-29 and NDVP-08 variety. Khurdiya *et al.* (1972) also observed a decrease in ascorbic acid content of dried peas over 6 month of storage period. Similarly in an earlier study loss of about 27.80 per cent in ascorbic acid was observed during storage of dehydrated pumpkin slice for three months (Pawar *et al.* 1985). Storage of dehydrated bitter ground chips for months caused a loss of about 28.33 per cent ascorbic acid (Manimegalai and Ramah, 1998). Reduction in ascorbic acid with storage was also noted earlier in banana powder (Oomen and Gruben, 1977) in dehydrated fenugreek (Patil *et al.,* 1978); in dehydrated tropical fruits (Mehta and Tomar, 1980); pomace powder (Chadha, 1993). Similarly, Sheriful (2002) reported that ascorbic acid content declined from 52.99 to 55.75 percent during storage of dehydrated peas for 6 months. The loss in ascorbic acid during storage may be because of oxidation of ascorbic acid during storage as vitamin C has greater sensitivity to oxygen, light and temperature.

Significant difference was observed in ascorbic acid content of variety HVP-01-29 during all the treatments and storage period. Similarly, significant differences in ascorbic acid content were noticed for other two varieties i.e. Azad and NDVP-08 for all the treatments and storage.

**Pigments**

**Total Chlorophyll:** Total chlorophyll content in frozen peas varied from 7.51 to 10.91 mg/100g (Table 4.46) in various varieties throughout the storage. Decline of 8.16 to 19.16 per cent in total chlorophyll was noticed on 0, $30^{th}$, $60^{th}$ and $90^{th}$ day of storage, which was statistically significant. Significant difference in total chlorophyll was noticed in various varieties. Azad variety was found to contain maximum total chlorophyll content followed by HVP-01-29 and NDVP-08. Similar trend was noticed in various varieties during storage. Similarly in an earlier study of Pawar *et al.* (1994) the total chlorophyll content varied from 0.39 to 0.31 (mg/g, d.b.) during frozen storage of peas blanched in $NH_4HC_3$ solution stored for 4½ months.

Total chlorophyll content in sun dried peas varied from 18.89 to 36.26 mg/100g in various varieties during the storage. Significant decline of 13.78 to 38.81 per cent in total chlorophyll on 0, $30^{th}$, $60^{th}$ and $90^{th}$ day of storage. Significant difference in total chlorophyll was noticed in various varieties. Total chlorophyll was found to be maximum in Azad variety followed by HVP-01-29 and NDVP-08 variety. Same trend was noticed during storage in various varieties.

**Table 4.46 : Effect of storage on total chlorophyll content (mg/100g) of frozen and dried pea varieties**

| Variety | Storage period (days) | | | | |
|---|---|---|---|---|---|
| **Freezing** | **0** | **30** | **60** | **90** | **CD (<0.05)** |
| HVP-01-29 | 9.29±0.01 | 8.26±0.003 (11.08) | 7.90±0.02 (14.96) | 7.51±0.02 (19.16) | 0.05 |
| *Azad* | 10.90±0.01 | 10.01±0.08 (8.16) | 9.90±0.03 (9.17) | 9.21±0.01 (15.50) | 0.06 |
| NDVP-08 | 9.25±0.02 | 8.65±0.01 (9.18) | 7.91±0.02 (14.48) | 7.52±0.00 (18.80) | 0.10 |
| **CD (<0.05)** | 0.06 | 0.03 | 0.09 | 0.04 | |
| **Sun drying** | | | | | |
| HVP-01-29 | 36.15±0.05 | 30.83±0.01 (14.71) | 26.46±0.02 (26.80) | 22.12±0.01 (38.81) | 0.09 |
| Azad | 36.26±0.01 | 30.37±0.03 (16.24) | 20.27±0.01] (27.55) | 23.42±0.00 (35.14) | 0.02 |
| NDVP-08 | 32.80±0.26 | 29.28±0.02 (13.78) | 22.34±0.01 (31.89) | 18.89±0.05 (30.45) | 0.06 |
| **CD (<0.05)** | 0.54 | 0.03 | 0.05 | 0.11 | |
| **Oven drying** | | | | | |
| HVP-01-29 | 40.12±0.02 | 36.64±0.02 (8.67) | 30.69±0.01 (23.50) | 26.14±0.08 (34.84) | 0.06 |
| Azad | 40.10±0.01 | 36.51±0.00 (8.95) | 30.20±0.01 (24.68) | 26.91±0.03 (32.89) | 0.03 |
| NDVP-08 | 36.11±0.01 | 32.43±0.13 (10.19) | 28.17±0.02 (21.98) | 22.42±0.01 (37.91) | 0.07 |
| **CD (<0.05)** | 0.07 | 0.07 | 0.04 | 0.03 | |
| **CD (<0.05) :** | | | | | |
| HVP-01-29 | 0.04 | 0.05 | 0.06 | 0.05 | |
| Azad | 0.03 | 0.02 | 0.07 | 0.03 | |
| NDVP-08 | 0.04 | 0.07 | 0.05 | 0.11 | |

Values are mean ± SE three independent determination

Figures in parenthesis indicate percent change compared to zero day

Total chlorophyll content in oven dried peas ranged from 22.42 to 40.12 mg/100g in various varieties throughout the storage. Decline of 8.67 to 37.91 per cent in total chlorophyll was noticed on 0, 30$^{th}$, 60$^{th}$ and 90$^{th}$ day of storage and decline was found to be significant. Significant difference in total chlorophyll was noticed in various varieties. It was found that Azad variety contained maximum total chlorophyll followed by HVP-01-29 and NDVP-08 variety. Similar trend was observed in various varieties during storage. The loss of chlorophyll during the storage of dried peas has also been reported by various workers (Khuridya *et al.* 1972; Das *et al.* 1993 and Sheriful, 2002). Similarly, chlorophyll content declined from 50.10 to 27.54 mg/100g during the storage of dehydrated peas for 2 months as reported by Ruchika (2004).

Significant difference was observed in chlorophyll content of variety HVP-01-29 during all the treatment and storage period. Similarly significant differences in total chlorophyll content were noticed for all the varieties i.e. Azad and NDVP-08 for all treatments (freezing, sun drying and oven drying) and storage.

Thus, it was observed that varieties. HVP-01-29, Azad and NDVP-08 were nutritionally better than the other varieties and were suitable for processing. The processed peas retained their nutritional composition and organoleptic characteristics till the end of storage period of three months.

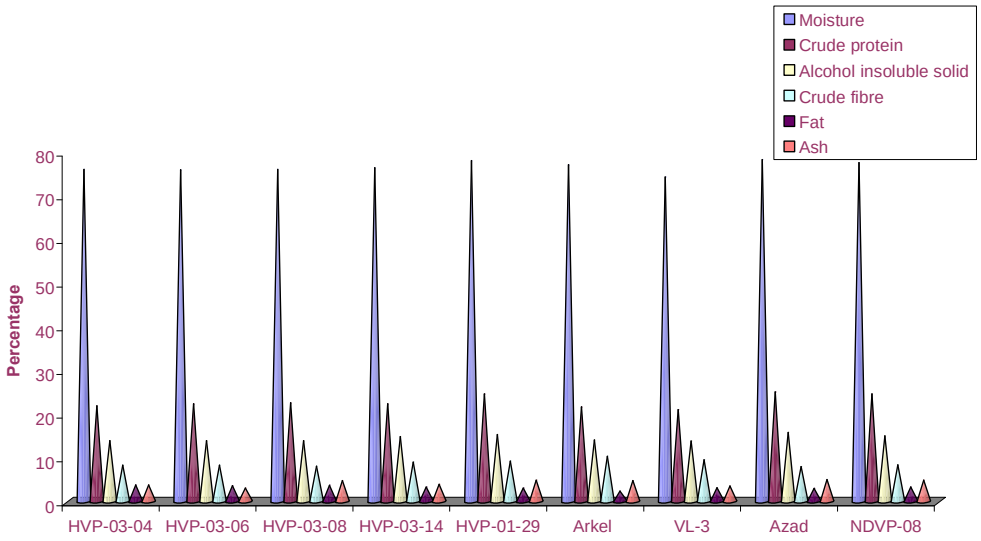



**Fig. 1 : Proximate composition of pea varieties**

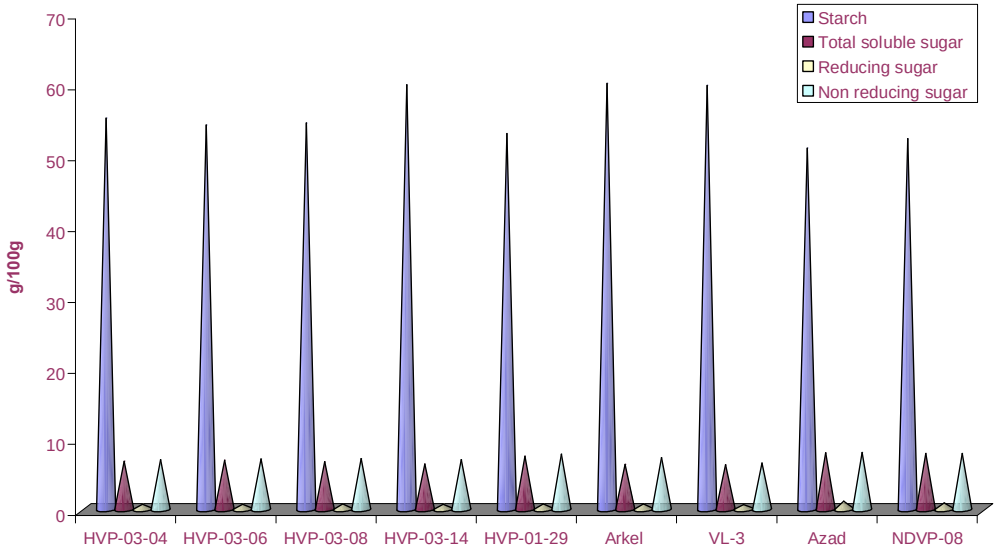



**Fig. 2 : Carbohydrates content of pea varieties**

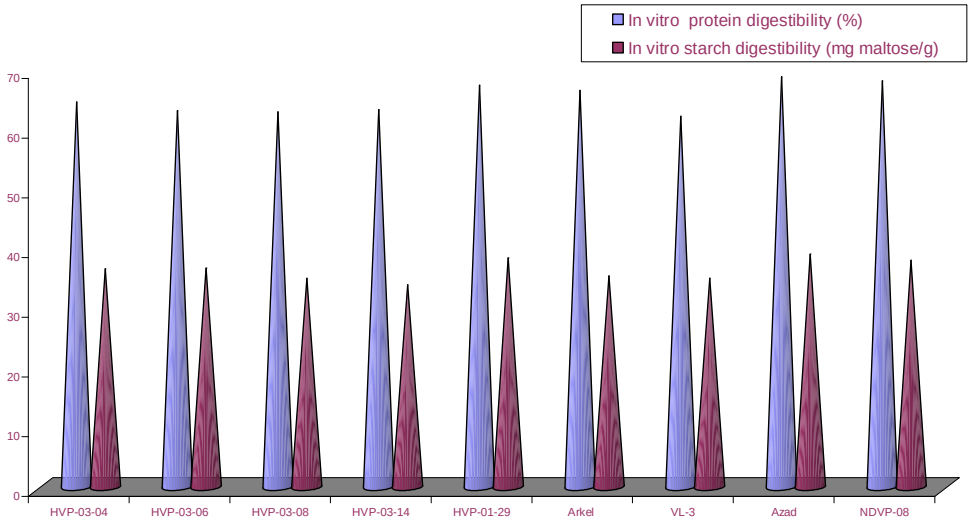



**Fig. 3 : *In vitro* protein and starch digestibility of pea varieties**

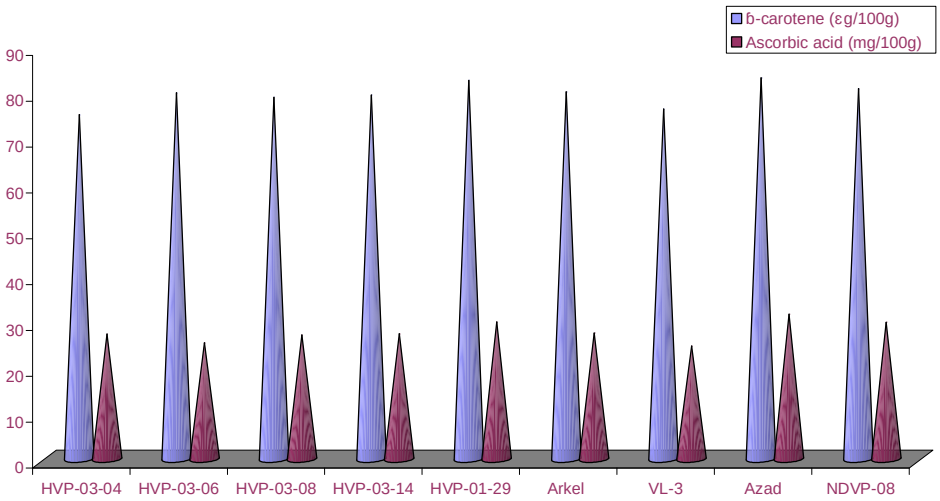



**Fig. 4 : Vitamin content of pea varieties**

**CHAPTER-V**

# *Summary and Conclusion*

The present study was undertaken for the nutritional evaluation and processing of pea (*Pisum sativum varieties sativum*) varieties. Samples of pea varieties i.e. HVP-03-04, HVP-03-06, HVP-03-08, HVP-03-14, HVP-01-29, Arkel, VL-3, Azad and NDVP-08 were obtained from Department of Vegetable Science, CCS Haryana Agricultural University, Hisar. Pea varieties were analyzed for physical properties, proximate composition, carbohydrates, *in vitro* digestibility, total mineral, antinutrients, vitamin and pigments. Fresh pea varieties were utilized for the development of dry and curry vegetable and their organoleptic acceptability was studied. On the basis of nutritional evaluation and acceptability trials, the three varieties i.e. HVP-01-29, Azad and NDVP-08 found best were subjected to processing methods i.e. freezing and dehydration (sun drying and oven drying) for extending their shelf life. Stored dehydrated and frozen samples were nutritionally analyzed for proximate composition, carbohydrates, *in vitro* digestibility, total minerals, antinutrients, vitamins, cooking quality and pigment at 0, $30^{th}$, $60^{th}$ and $90^{th}$ day storage. At each storage interval frozen and dried peas were used for development of dry and curry vegetable and evaluated organoleptically.

The results of physical properties indicated that pod length, pod width, pod thickness, pod weight, grain weight, shell weight, shelling percentage and pea grain to shell ratio varied from 85.50 to 100.70 mm,

16.20 to 22.60 mm, 14.60 to 19.20 mm, 3.52 to 5.20 g, 1.66 to 2.78 g, 1.50 to 2.64 g, 46.18 to 56.40 percentage and 1.05 to 1.19 respectively.

The results of proximate composition revealed that the moisture content of all pea varieties varied from 74.31 to 78.30 per cent and fat content from 2.97 to 3.80 per cent. The crude protein ash and crude fibre content ranged from 21.04 to 25.11, 3.10 to 4.98 and 8.00 to 10.34 per cent respectively. The alcohol insoluble solid content on fresh and dry matter basis varied from 13.87 to 15.77 and 56.31 to 60.51 per cent respectively in various pea varieties. With regards to protein, ash and alcohol insoluble content HVP-01-29, Azad and NDVP-08 had higher protein, ash and alcohol insoluble content as compared to other varieties.

The starch and total soluble sugars content ranged from 50.98 to 60.10 and 6.30 to 8.01 per cent respectively. Reducing and non-reducing sugars varied from 0.70 to 1.15 and 6.55 to 8.02 per cent respectively. Total soluble sugars, reducing and non reducing sugars were higher in varieties i.e. Azad, HVP-01-29 and NDVP-08 than the other varieties.

*In vitro* protein digestibility of pea varieties studied ranged from 62.10 to 68.73 per cent while, starch digestibility ranged from 33.87 to 39.03 mg maltose released per gram.

Mineral profile of pea varieties suggested that level of calcium, iron and zinc ranged from 28.43 to 36.27, 8.66 to 13.91 and 3.04 to 5.46 mg/100g, respectively.

Among the antinutrients, phytic acid and polyphenols content of pea varieties ranged widely from 587.07 to 757.76 and 1020 to 1210 mg/100g respectively in different varieties of pea. It was observed that

HVP-01-29, Azad and NDVP-08 variety contained lower antinutrient content and had higher digestibilities as compared to other varieties.

Vitamin content was also studied and it was found that ɓ-carotene and ascorbic acid content varied from 75.18 to 83.15 µg/100g and 24.63 to 31.58 mg/100g respectively. Varieties i.e. HVP-01-29, Azad and NDVP-08 contained higher vitamin content as compared to other varieties. Under pigment, total chlorophyll was studied and it ranged from 9.30 to 11.90 mg/100g in various varieties.

Cooking time in various pea varieties ranged from 13 to 18 minutes. HVP-01-29, Azad and NDVP-08 varieties were found to have lower cooking time as compared to other varieties. Azad and NDVP-08 varieties had similar cooking time (14 minutes).

The results of organoleptic evaluation of dry and curry vegetable prepared from various fresh pea varieties indicated that these were acceptable and were liked moderately. Mean scores of appearance and texture of dry vegetable prepared from various varieties were similar whereas mean scores of colour, flavour, taste and overall acceptability of dry vegetable prepared from HVP-01-29, Azad and NDVP-08 were significantly higher as compared to other varieties. Similarly, mean scores of appearance and flavour of curry vegetable prepared from pea varieties were similar while mean scores of colour, texture, taste and overall acceptability of curry vegetable prepared from varieties i.e. HVP-01-20, Azad and NDVP-08 were significantly higher than other varieties.

The physical properties, proximate composition and organoleptic acceptability indicated that the three pea varieties i.e. HVP-01-29, Azad and NDVP-08 were found to be best and were processed for dehydration

(sun drying and oven drying) and freezing. The processed peas (frozen and dehydrated) were analyzed for cooking quality i.e. swelling capacity, hydration capacity, cooking time and soaking time. There was non-significant decline in swelling capacity of sun dried peas during storage. Non-significant differences in swelling capacity of sun dried peas of various pea varieties were observed. Same trend was observed in oven dried peas. Intra varietal differences in swelling capacity of various varieties during different treatments were found to be statically non-significant. Hydration capacity in sun dried peas did not change throughout the storage. Significant difference in hydration capacity of sun dried peas of various varieties was noticed. Similar trend was noticed in oven dried peas. Non-significant intra varietal differences in hydration capacity of various varieties during different treatments were observed. Cooking time in frozen peas remained same during storage. Whereas non-significant difference in cooking time of various frozen peas varieties was noticed .The trend remained same in sun dried and oven dried peas. Intra varietal differences in cooking time of various varieties during different treatments were observed to be statistically significant Thus it was concluded that swelling capacity, hydration capacity and cooking time did not change upto the end of storage period of three months.

The results obtained for organoleptic acceptability dry and curry vegetables prepared from frozen and dehydrated peas indicated that dry and curry vegetables were in the category of liked moderately. Mean scores of colour of dry vegetable prepared from frozen peas indicated that there was non-significant difference in colour during the storage period. Significant difference in mean scores of colour of dry vegetable prepared

from frozen pea varieties was observed. Similar trend was noticed in mean scores of colour of dry vegetable prepared from sun dried peas. Whereas, mean scores of colour of dry vegetable prepared from oven dried peas differed non-significantly throughout the storage. Mean scores of colour of dry vegetable prepared from various varieties were observed to be non-significant. Intra varietal differences in colour during different treatments were found to be statistically non-significant for all varieties. Mean scores of appearance of dry vegetable prepared from frozen pea varieties differed non-significantly during storage. Whereas, appearance of dry vegetable prepared from frozen peas differed significantly. The trend remained same in sun and oven dried peas. Intra varietal differences in appearance of dry vegetable in different treatments for all varieties were found to be non-significant. Non-significant difference in mean scores of flavour of dry vegetable was observed during storage. Significant difference in flavour of dry vegetable prepared from various varieties was noticed. The trend remained same in sun dried and oven dried peas. Intra varietal differences in flavour of dry vegetable in different treatments were found to be non-significant for HVP-01-29 and Azad whereas it was significant for NDVP-08 variety. The texture of the dry vegetable prepared from frozen peas remained same through out the storage. There was non significant difference in the texture of dry vegetable prepared from various varieties. Similar trend was observed in oven dried peas. Whereas in sun dried peas there was significant difference in the mean scores of texture of dry vegetable prepared from various varieties. Intra varietal differences in texture of dry vegetable in different treatments were found to non-significant for HVP-01-29 and

Azad varieties whereas the difference was significant in NDVP-08 variety. The taste of the dry vegetable prepared from frozen peas did not change during the storage. Also the difference in the mean score of taste of dry vegetable prepared from various varieties was non-significant. The same trend was observed in mean scores of texture of sun dried and oven dried peas. Intra varietal differences in taste of dry vegetable in different treatments in all varieties were found to be statically non-significant. There was non significant difference in mean scores of overall acceptability of dry vegetable prepared from frozen peas during the storage. Significant difference in mean scores of overall acceptability of dry vegetable prepared from frozen pea varieties was observed. Similar trend was noticed in sun dried and oven dried peas. Intra varietal differences in overall acceptability of dry vegetable during different treatments in various varieties were found to be significant. Thus it was observed that organoleptic characteristics i.e. colour, appearance, flavour, texture and overall acceptability of dry vegetable prepared from frozen, sun dried and oven dried peas remained same and acceptable till the end of storage period of 90 days.

Mean scores of colour of curry vegetable prepared from frozen peas did not change during storage. Also non-significant difference was observed in colour of curry vegetable prepared from various varieties. Similar trend was noticed for sun dried and oven dried peas. The intra varietal differences in colour of curry vegetable during different treatments for all varieties were found to be non-significant. Same trend was noticed in appearance of curry vegetable. There was non-significant difference in mean scores of flavour of curry vegetable prepared from

frozen peas during storage. Difference in mean score of flavour of curry vegetable prepared from various varieties was found to be significant. The same trend was noticed in sun dried peas. The flavour of dry vegetable prepared from oven dried peas remained same throughout the storage. There was non-significant difference in flavour of vegetable prepared from various varieties. The intra varietal differences in flavour of curry vegetable during different treatments for all varieties were statically non-significant. The difference in texture of dry vegetable prepared from frozen peas was non-significant throughout the storage period. There was non significant difference in texture of curry vegetable prepared from various varieties. Texture of curry vegetable prepared from sun dried peas remained same throughout the storage. Significant difference was noted in texture of curry vegetable prepared from various varieties. Changes in texture of oven dried pea was same as in frozen peas. Intra varietal differences in texture of curry vegetable in different treatments were found to be non-significant for HVP-01-298 and Azad variety whereas it was significant for NDVP-08 variety. Non-significant difference was observed in taste of curry vegetable prepared from frozen peas during storage. Non-significant difference was observed in taste of curry vegetable prepared from various varieties. Same trend was observed in sun dried peas. There was no change in the taste of curry vegetable during storage. Significant difference was noticed in taste of curry vegetable prepared from various varieties. Intra varietal differences in taste of curry vegetable during different treatments were found to be non-significant for all varieties. Non-significant difference in overall acceptability of curry vegetable prepared from frozen peas was observed.

There was also non-significant difference in overall acceptability of curry vegetable prepared from various varieties. Same trend was noticed in oven dried peas. Non-significant difference was observed in overall acceptability of curry vegetable of frozen peas during storage. There was non-significant difference in the overall acceptability of curry vegetable prepared from various pea varieties. Intra varietal differences in overall acceptability of curry vegetable during different treatments were found to be non-significant. Thus it was observed that organoleptic characteristics i.e. colour, appearance, flavour, texture and overall acceptability of curry vegetable prepared from frozen, sun dried and oven dried peas remained same and acceptable till the end of storage period of 90 days.

Storage studies indicated that moisture content in frozen peas decreased (0.61-1.91%) significantly throughout the storage period. The moisture content ranged from 77.00 to 79.18 per cent during storage. Significant difference in moisture content of various frozen varieties was also found. Moisture content in sun dried and oven dried peas decreased significantly from 1.42 to 2.05 and 1.38 to 2.04 per cent respectively. Significant difference was observed in the moisture content of various varieties during all the treatments and storage. Moisture content of sun dried and oven dried peas was almost similar during storage. Protein content declined significantly during the storage of frozen, sun dried and oven dried peas. The value of protein content ranged from 22.16 to 23.93, 21.96 to 23.87 and 22.04 to 23.89 per cent in frozen, sun dried and oven dried peas respectively. Intra varietal differences in protein content during different treatments in various varieties were found to be significant. Protien content of sun dried and oven dried peas was almost similar

during storage. There was slight but significant decrease in fat content ranging from 3.09 to 9.03, 4.05 to 14.86 and 4.04 to 14.47 per cent in frozen peas, sun dried and oven dried peas respectively during storage. Intravarietal difference in fat content was found to be non-significant during different treatments in HVP-01-29 variety whereas significant intravarietal differences in fat content were observed in Azad and NDVP-08 varieties. Ash content in frozen, sun dried and oven dried peas ranged from 4.45 to 4.86, 4.1 to 4.83 and 4.15 to 4.85 per cent respectively. The ash content declined significantly in all the treatments throughout the storage. Intravarietal differences in ash content were found to be significant during different treatments in various varieties. Ash content of sun dried and oven dried peas was almost similar during storage.

Fibre content decreased slightly but significantly by 0.85 to 3.14, 1.15 to 3.35 and 1.14 to 3.80 per cent in frozen sun dried and oven dried peas during storage. Fibre content differed significantly in various varieties during different treatments and storage. Fibre content was almost similar in sun dried and oven dried peas during storage period. Alcohol insoluble solid content showed a significant reduction of 3.44 to 8.90, 5.93 and 5.82 to 24.15 per cent in frozen, sun dried and oven dried peas during storage. There was significant difference in alcohol insoluble solid content of various varieties during storage. Intra varietal differences in AIS content were found to be significant in various varieties during storage.

Starch content of frozen, sun dried and oven dried peas reflected significant reduction of 0.23 to 0.94, 0.42 to 2.05 and 0.40 to 1.71 per cent respectively till the end of storage. Significant difference in starch

content of various frozen, sun dried and oven dried pea varieties was also observed. Intra varietal differences in starch content during different treatments and storage in various varieties were found to be statistically significant. Total soluble sugar content indicated significant reduction of 1.89 to 4.38, 5.17 to 19.08 and 3.65 to 18.96 per cent in frozen, sun dried and oven dried peas by the end of storage of 90 days. There was significant difference in total soluble sugar content of various frozen, sun dried and oven dried peas varieties. Statistically significant intra varietal differences in total soluble sugar were noticed in various varieties during different treatments and storage. Reducing sugar content declined from 1.10 to 0.54, 1.57 to 1.32 and 1.54 to 1.31 g/100g on zero day of storage to $90^{th}$ day of storage in frozen sun dried and oven dried peas respectively. Significant difference in reducing sugar content of various frozen, sun dried and oven dried peas was also noticed. Intra varietal differences were found to be significant in reducing sugars of different varieties during different treatments and storage. Non-reducing sugar content of frozen, sun dried and oven dried peas decreased significantly by 7.32, 5.16 and 5.32 per cent respectively till the end of the storage period. There was significant difference in non-reducing sugars of various frozen, sun dried and oven dried pea varieties. It was found that intra varietal differences in non-reducing sugars of different varieties during different treatments and storage were statically significant. Reducing and non reducing sugar content of sun dried and oven dried peas was almost similar during storage period. *In vitro* protein digestibility of frozen, sun dried and oven dried peas decreased from 70.96, 75.01 and 76.06 per cent to 66.10, 69.15 and 69.69 per cent on $90^{th}$ day of storage. Significant

difference in *in vitro* protein digestibility of various frozen, sun dried and oven dried peas was noticed. Statistically significant intra varietal differences in *in vitro* protein digestibility were observed in different varieties during different treatments and storage. *In vitro* starch digestibility decreased significantly by 7.35, 9.25 and 9.27 per cent frozen, sun and oven dried peas by the end of storage study. There was significant difference in *in vitro* starch digestibility of various frozen, sun dried and oven dried peas. Intra varietal differences were noticed to be statistically significant in *in vitro* starch digestibility of different varieties during storage.

Iron content of frozen, sun dried and oven dried peas decreased from 13.75, 13.07 and 13.27 mg/100g to 10.76, 10.41 and 10.97 mg/100g respectively on $90^{th}$ day of storage. Significant difference in iron content of various frozen, sun dried and oven dried pea varieties was noticed. Intra varietal differences in iron content of various varieties during different treatments and storage were noticed to be significant. Zinc content showed a significant reduction of 0.82 to 5.66, 2.15 to 10.05 and 2.52 to 9.46 per cent in frozen, sun dried and oven dried peas respectively by the end of storage period. Zinc content showed significant difference in various frozen, sun dried and oven dried pea varieties. Significant intra varietal differences in zinc content of various varieties during different treatments and storage were noticed. Calcium content of frozen, sun dried and oven dried peas showed significant decline from 3.12, 26.89 and 28.89 mg/100g on zero day to 27.49, 23.33 and 25.36 mg/100g in frozen, sun dried and oven dried pea varieties respectively on $90^{th}$ day of storage. Significant difference in calcium content of various frozen, sun dried, and

oven dried pea varieties was observed. There were significant intra varietal differences in calcium content of various varieties during different treatments and storage.

Phytic acid content of frozen peas increased non-significantly during the storage period. Phytic acid content of sun dried and oven dried peas increased significantly by 6.05 and 5.04 per cent respectively throughout the storage period. Phytic acid content showed significant difference in various frozen, sun dried and oven dried pea varieties. Significant intra varietal differences in phytic acid content of various varieties during different treatments and storage were observed. Polyphenol content increased non-significantly in frozen peas during storage. Polyphenol content increased significantly in sun dried and oven dried peas and the value ranged from 530.00 to 604.12 and 524.20 mg/100g in sun dried and oven dried peas respectively. Polyphenol content differed significantly in various frozen, sun dried and oven dried pea varieties. Intra varietal differences in polyphenol content of various varieties during different treatments and storage were found to be significant.

ɓ-carotene of frozen, sun dried and oven dried peas reflected significant reduction of 1.04 to 6.01, 4.22 to 18.26 and 4.55 to 17.11 per cent respectively till the end of storage period of three months. ɓ-carotene differed significantly in various frozen, sun dried and oven dried pea varieties. There were significant intra verietal differences in ɓ-carotene content of various varieties during different treatments throughout the storage. Ascorbic acid content indicated significant reduction of 0.64 to 3.53, 7.44 to 14.70 and 5.99 to 13.85 per cent in frozen, sun dried and

oven dried peas respectively during storage period. There was significant difference in ascorbic acid content of various frozen, sun dried and oven dried pea varieties. It was found that there were significant intra varietal differences in ascorbic acid content of various varieties during different treatments throughout storage period.

Total chlorophyll content in frozen, sun dried and oven dried peas reflected significant reduction of 8.16 to 19.16, 13.78 to 38.81 and 8.67 to 37.91 per cent respectively throughout the storage period. Total chlorophyll content differed significantly in various frozen, sun dried and oven dried pea varieties. Significant intra varietal differences in total chlorophyll content of various varieties during different treatments throughout the storage period were observed.

Pea varieties i.e. HVP-01-29, Azad and NDVP-08 were found suitable for processing (freezing, sun drying and oven drying). They retained their nutritional composition and organoleptic characteristics till the end of storage period of three months. Thus, peas can be stored for longer period in form of dried and frozen peas without much loss of nutrients as processed peas were found nutritionally good upto the end of storage period instead of slight decrease in their nutritional composition. The frozen and dehydrated peas in addition to their improved quality, economics, nutritive value and consumer acceptability, can help farmers and processors in overcoming post harvest losses due to seasonal gluts, to get remunerative prices and helpful in crop diversification. Dehydration and freezing can also be taken as entrepreneurial activity at household level for income generation.

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## APPENDIX- I

### 9-Hedonic Rating Scale

**Name ----------** **Dated ----------**

**Products ----------**

Test these samples and check how much you like or dislike each one. Use appropriate scale to show your attitude by assigning points that best describe your feelings about the sample. An honest expression of your feelings will help us.

| Sr. No. | Colour | Appearance | Aroma | Texture | Taste | Overall acceptability | Remarks |
|---|---|---|---|---|---|---|---|

| Rate | Organoleptic score |
|---|---|
| Like extremely | 9 |
| Like very much | 8 |
| Like moderately | 7 |
| Like slightly | 6 |
| Neither like nor dislike | 5 |
| Dislike slightly | 4 |
| Dislike moderately | 3 |
| Dislike very much | 2 |
| Dislike extremely | 1 |

**Signature**

# Abstract

| | | | |
|---|---|---|---|
| 1. | **Title of thesis** | : | Nutritional evaluation and processing of pea (*Pisum sativum var. sativum*) varieties |
| 2. | **Full name of degree holder** | : | **SONIA TANDON** |
| 3. | **Admission No.** | : | 2004HS208M |
| 4. | **Title of degree** | : | Master of Science |
| 5. | **Name and address of Major Advisor** | : | Dr.(Mrs.) Salil Sehgal<br>Professor<br>Deptt. of Foods and Nutrition<br>I.C. College of Home Science<br>CCS Haryana Agricultural University<br>Hisar-125004 |
| 6. | **Degree awarding University/ Institute** | : | CCS Haryana Agricultural University, Hisar-125004 |
| 7. | **Year of award of degree** | : | 2006 |
| 8. | **Major subject** | : | Foods and Nutrition |
| 9. | **Total No. of pages in thesis** | : | 172 + xvii |
| 10. | **No. of words in the abstract** | : | Approx. 525 |

**(An abstract of the thesis submitted to the CCS Haryana Agricultural University in partial fulfilment of the requirements for the degree of M.Sc.)**

**Keywords:** Pea varieties, nutritional evaluation, processing, dehydrated peas, frozen peas, organoleptic acceptability

The present study was carried out for nutritional evaluation and processing of pea varieties i.e. HVP-03-04, HVP-03-06, HVP-03-08, HVP-03-14, HVP-01-29, Arkel, VL-3, Azad and NDVP-08.

Pod length, pod width, pod thickness, pod weight, grain weight, shell weight, shelling percentage and pea grain to shell ratio varied from 85.50 to 100.70 mm, 16.20 to 22.60 mm, 14.60 to 19.20 mm, 3.50 to 5.20 g, 1.66 to 2.78 g, 1.50 to 2.64 g, 46.18 to 56.40 per cent and 1.05 to 1.19 respectively in various pea varieties.

Moisture, fat, crude protein, ash, crude fibre, alcohol insoluble solid content in various varieties were found to vary from 74.31 to 78.30 per cent, 2.97 to 3.80 per

cent, 21.04 to 25.11 per cent, 3.10 to 4.98 per cent, 8.00 to 10.34 per cent and 13.87 to 15.77 per cent respectively.

Pea varieties were found to contain 50.98 to 60.10 per cent starch, 6.30 to 8.01 per cent of total soluble sugars, 0.70 to 1.15 per cent reducing sugars and 6.55 to 8.02 per cent of non-reducing sugars. Pea varieties contained 28.43 to 36.27, 8.66 to 13.91 and 3.04 to 5.46 mg/100g of calcium, iron and zinc, respectively. *In vitro* starch digestibility was 33.87 to 39.03 mg maltose released per gram and *in vitro* protein digestibility was 62.10 to 68.73 per cent. Phytic acid and polyphenol content ranged from 587.07 to 757.76 and 1020 to 1210 mg/100g respectively. Hundred gram of pea contained 75.18 to 83.15 µg of ɓ-carotene and 24.63 to 31.58 mg of ascorbic acid. Total chlorophyll content in various pea varieties ranged from 9.30 to 11.90 mg/100g. Cooking time was found to range from 13 to 18 minutes in various pea varieties. Curry vegetable and dry vegetable prepared from various pea varieties were organoleptically acceptable to the panel of judges.

On the basis of nutritional evaluation and acceptability trial basis three varieties i.e. HVP-01-29, Azad and NDVP-08 were selected for processing (sun drying, oven drying and freezing) and processed peas were then stored for 3 months. Dehydration and freezing was found effective in extending shelf life upto 90 days. Both the processes produced slight but significant decline in proximate composition, carbohydrates, *in vitro* digestibility and total minerals during storage. Antinutrients content increased during the storage period of 3 months. Hydration capacity, swelling capacity and cooking time in dehydrated peas remained same during storage. Ascorbic acid content of sun dried, oven dried and frozen peas decreased significantly by 7.44 to 14.70,5.99 to 13.85 and 0.64 to 3.53per cent whereas ɓ-carotene decreased by 4.22 to 18.26,4.55 to 17.11 and 1.04 to 6.01 per cent respectively by the end of 90 days of storage. Total chlorophyll also declined significantly during the storage period. Dry and curry vegetables prepared from both dehydrated (sun dried and oven dried) and frozen peas were found acceptable throughout the storage period. Pea thus can be utilized in preparation of wide variety of recipes and can be stored in frozen and dehydrated form.

**MAJOR ADVISOR** **DEGREE HOLDER**

**HEAD OF THE DEPARTMENT**