Chapter-V

DISCUSSION

The results obtained in the present investigation have been discussed in the light of available literature under the following subheads:

5.1 Physical characteristics

5.1.1 Colour

As is clear from the data in Table 4 and Plate 2, the colour of *Cassia tora* seeds was glossy dark brown. It has been reported by Victor and Abbott (2005) that the colour of sicklepod (*Cassia obtusifolia*) seeds is dark brown with a glossy surface.

5.1.2 Shape

Shape of *Cassia tora* seeds has been depicted in Table 4 and Plate 2.

5.1.3 Weight

A glance at Table 4 shows the weight of 1000 seeds of raw and roasted *Cassia tora*. As is clear from the Table, the weight of raw seeds was slightly higher than the roasted seeds. This might have been due to the reason that during roasting there are slight changes in moisture content of the grains. Joshi (2005) in her study reported that the weight of roasted fenugreek seeds is less than that of raw fenugreek seeds. Naeem and Khan (2007) reported that the weight of 100 *Cassia tora* seeds varied from 2.32 to 2.34 g.

5.1.4 Length

As shown in Table 4, the raw seeds of *Cassia tora* have a higher seeds length as compared to the roasted seeds. A decrease was observed in the seed length in the roasted seeds of *Cassia tora*. This decrease in length might have been due to the moisture losses during roasting. As a result the shrinkage of seeds occurred. It has been reported
by Mankotia and Modgil (2003) that cooking resulted in decrease in the length of cowpea. According to them, the decrease in length of cooked grains was due to shrinkage which is due to extraction of tissue water during cooking. The results of the present study are at par with this investigation.

5.1.5 Width

As is clear from the data given in Table 4, roasting resulted in a decrease in width of *Cassia tora* seeds as compared to their raw counterparts. This might have been due to the reason that during roasting, there is a loss of internal moisture present in the tissues of the seeds which results in the shrinkage of grains and as result width decreases. Mankotia and Modgil (2003) have reported similar results for grains of cowpea. Joshi (2005) also reported similar results for fenugreek seeds.

5.1.6 Density

As is evident from Table 4, the weight volume ratio (density) of raw seeds of *Cassia tora* was slightly higher than that of the roasted seeds. This might have been due to the reason that in roasting the internal tissue moisture losses are there which result in a decrease in the weight of seeds and hence, the density of roasted grains decreases. Joshi (2005) reported that the density of the roasted fenugreek seeds is less than that of raw seeds.

5.2 Proximate composition

5.2.1 Moisture

Moisture content of raw and roasted *Cassia tora* seeds is depicted in Table 5. As is clear from the Table, the moisture content of raw seeds was higher (4.66 ± 0.07) than that of roasted *Cassia tora* seeds (2.25 ± 0.02). The decrease in moisture content in roasted sample might have been due to the loss of water from the internal tissue of seeds.
due to increased heating. Joshi (2005) reported similar trend in the moisture content of fenugreek seeds. Yen et al. (1998) analyzed the moisture content of Cassia tora seeds to be 5.83%.

5.2.2 Ash

According to the data given in Table 5, ash content of the raw seeds of Cassia tora was higher (3.67 ± 0.04) than that of roasted seeds (2.84 ± 0.04). Ash is an organic material and is present in the bran portion of the seeds. In roasting, the decrease in ash content might have been due to the reason that there are losses in nutrient composition of seeds. Joshi (2005) reported a similar trend in the ash content of raw and roasted fenugreek seeds. Yen et al. (1998) analyzed the ash content of Cassia tora seeds to the value of 4.83% which is slightly different as per the results of present study, which might have been due to different agro climatic conditions and varietal differences. Vadivel and Janardhanan (2002) reported that ash content in Cassia tora seeds ranged from 5.14-5.83%.

5.2.3 Crude fat

Table 5 shows the crude fat content present in the Cassia tora seeds. As given in the Table, the fat content of roasted seeds was less (0.82 ± 0.04) than that of raw Cassia tora seeds (1.10 ± 0.01). Roasting may have resulted in a reduction in fat content due to loss during heating. A decrease in fat content might have also been due to various physico-chemical changes going on in the seeds during heating.

Yen et al. (1998) observed the fat content of Cassia tora seeds to be 5.31% which is very high as compared to the present results. Less fat content observed in the present study might have been due to different agro-climatic conditions and varietal differences.
5.2.4 **Crude protein**

As is clear from the data in Table 5, the protein content in raw *Cassia tora* seeds was 2.37 per cent more than roasted seeds. This might have been due to the reason that during roasting denaturation of protein occurs. Tomar *et al.* (1996) conducted the biochemical evaluation of some forest tree seeds including *Cassia tora* seeds and reported protein content to be in the range of 21-25%. Vadivel and Janardhanan (2002) studied *Cassia obtusifolia* L. seeds from four different agro climatic regions and reported the crude protein content to be ranging from 18.56-22.93%. The protein content of *Cassia tora* seeds as analyzed by Yen *et al.* (1998) is 17.70%. The values reported earlier were more than that observed in the present investigation.

5.2.5 **Crude fiber**

Data in Table 5 depicts the crude fiber content of raw and roasted *Cassia tora* seeds. As is clear from the Table the crude fiber content was less (4.02 ± 0.10) in raw *Cassia tora* seeds as compared to the roasted seeds (4.91 ± 0.47). Roasting resulted in an increase in crude fiber content of the seeds, which might have been due to the moisture losses during heating, as a result other nutrients come in concentrated form. In a study carried out by Vadivel and Janardhanan (2002) the crude fiber content in *Cassia obtusifolia* L. was reported to range from 6.83-9.45%. Yen *et al.* (1998) reported that *Cassia tora* seeds contain 23.97% crude fiber which is very high as compared to the results of the present study and this might have been due to different agro climatic conditions.
5.3 Nutritional composition

5.3.1 Non protein nitrogen (NPN)

Data given in Table 6 shows the NPN content of raw and roasted *Cassia tora* seeds. As is evident from the data, roasting resulted in an increase (33%) in the NPN content as compared to the raw samples. This increase in NPN content of roasted seeds might have been due to the reason that during heating, some degradation of enzymes takes place resulting in an increase in NPN content. Mankotia and Modgil (2003) reported an increase in NPN content in legumes due to domestic processes like roasting.

5.3.2 True protein

As is clear from Table 6, roasting affects the true protein content of *Cassia tora* seeds. The true protein content of raw seeds was 3.24 g higher than that of roasted seeds. True protein content is the difference of crude protein and NPN. A decrease in true protein content during roasting might have been due to the reason that enzymes get degraded by heating and there is an increase in NPN content so the true protein content decreases. Similar results have been reported by Joshi (2005) for raw and roasted fenugreek seeds.

5.3.3 Free amino acids

Data given in Table 6 depicts the free amino acid content of raw and roasted *Cassia tora* seeds. As is clear from the Table, the free amino acid content of raw *Cassia tora* seeds was 36% more than that of roasted seeds. This decrease in free amino acid content during roasting might have been due to the reason that amino acids get degraded by heating and thus a reduction in free amino acids.
5.3.4 Total carbohydrates

As is clear from Table 7, higher content (76.84 ± 0.10) of carbohydrates was there in the roasted seeds of *Cassia tora* as compared to that of raw seeds (71.84 ± 0.49). Roasting resulted in an increase in total carbohydrate content which might have been due to the reason that during roasting, moisture losses are there and so the nutrients become more concentrated. Heat processing also changes the chemical nature of any food. Cell structure becomes harder leading to an increase in unavailable carbohydrates. According to a study carried out by Vadivel and Janardhanan (2002), the carbohydrate content of *Cassia tora* seeds has been reported to be ranging from 57.00-60.69%. Crawford *et al.* (1990) reported that *Cassia tora* contains 66-69% carbohydrates. Higher values are observed in the present study which might be due to different agro-chemical conditions.

5.3.5 Sugars

5.3.5.1 Reducing sugars

Table 7 shows the content of reducing sugars in raw and roasted *Cassia tora* seeds. As is clear from the Table, roasting resulted in an increase reducing sugar content of *Cassia tora* seeds. This increase during roasting might have been due to biochemical changes taking place during heating, as a result complex carbohydrates are broken into simpler ones.

5.3.5.2 Non-reducing sugars

Table 7 depicts the non-reducing sugar content of raw and roasted seeds of *Cassia tora*. As is clear from the Table the content of non-reducing sugars was less in raw *Cassia tora* seeds as compared to that in roasted *Cassia tora* seeds. This increase
during roasting might have been due to biochemical changes taking place during heating. As a result, complex carbohydrates are broken into simpler ones. Similar results have been reported by Joshi (2005), that the non-reducing sugar content increased during roasting in fenugreek seeds.

5.3.5.3 Total sugars

Table 7 shows the total sugar content of raw and roasted *Cassia tora* seeds. As is clear from the Table, the amount of total sugars in raw samples was less than that of roasted samples. During roasting increase in total sugars might have been due to the biochemical changes taking place during heating. As a result complex carbohydrates are broken into simpler ones.

5.3.6 Energy

As is clear from Table 7, roasting affected the energy value of seed grains. The energy content of raw *Cassia tora* seeds was higher than the energy content of roasted seeds. This decrease in the energy content during roasting might have been due to the loss of nutrients which takes place during heating of seeds. Sankhala *et al.* (2005) studied the nutrient composition of *Cassia tora* leaves and reported the energy content in the leaves to be 97 Kcal/100g.

5.3.6 Dietary fiber constituents

The ADF residue consists of cellulose, lignin, cutin and acid-insoluble ash (mainly silica). The ADF procedure provides a method for lignocellulose determination of feeding stuffs. The NDF procedure for cell wall constituents is a method for analyzing total fiber in feeding stuffs (James and Theander, 1980).
5.3.7.1 Lignin

A glance at Table 8 depicts the lignin content of *Cassia tora* seeds. As is clear from the Table, the lignin content of roasted *Cassia tora* seeds was higher than that of raw seeds. This might have been due to increase in ADF content in the roasted seeds, lignin being one of the constituents of ADF. This increase in ADF content during roasting might have been due to the reason that during heating proteins get denatured and bran becomes hard leading to an increase in ADF content. Joshi (2005) reported the similar trend in ADF content of raw and roasted fenugreek seeds.

5.3.7.2 Cellulose

It is evident from Table 8 the cellulose content of raw *Cassia tora* seeds was lesser than that of roasted *Cassia tora* seeds. Roasting resulted in an increase in cellulose content which might be due to higher amount of ADF present in them as compared to their raw counterparts. This increase might have also been due to the reason that moisture reduces during roasting and as a result more fibrous complex are formed.

5.3.7.3 Hemicellulose

As is evident from Table 8, the hemicellulose content of roasted seeds of *Cassia tora* was lesser than that of raw seeds. Hemicellulose is the difference between NDF and ADF, NDF being the soluble form of fiber and ADF and hemicellulose being the insoluble forms. The content of NDF and ADF was higher in roasted seeds, thus, resulting in lower content of hemicellulose. The increase in NDF during roasting may be attributed to formation of new components such as maillard products or products formed from condensation of proteins and tannins which may be isolated as a component of fiber (Vidal Valverde and Frias, 1992).
5.3.8 **Free fatty acids**

Data given in Table 9 presents the free fatty acid content of *Cassia tora* seeds. As is clear from the Table, the free fatty acid content was almost same in raw and roasted *Cassia tora* seeds. The content of free fatty acids usually increases on repeated heating, however in the present study, no significant change was observed which may be attributed to a lesser exposure of seeds to heat.

5.3.9 **Peroxide value**

Peroxide value of raw (1.07 ± 0.21) and roasted (1.02 ± 0.03) *Cassia tora* seeds has been observed to be almost same. Peroxide value follows an increasing trend on repeated heating, however in the present study, no significant change was observed which may be attributed to a lesser exposure of seeds to heat.

5.4 **Anti-nutritional factors**

5.4.1 **Phytic acid**

Data given in Table 10 presents the phytic acid content of *Cassia tora* seeds. As is clear from the Table, the phytic acid content was higher in raw sample and lower in roasted sample. Roasting resulted in a decrease in phytic acid content which might have been due to the reason that phytic acid is heat labile and is lost during heat treatment.

5.4.2 **Trypsin inhibitor activity (TIA)**

Data in Table 10 shows the trypsin inhibitor activity of raw and roasted seeds of *Cassia tora*. As is clear from the Table, that roasting led to a decrease in the trypsin inhibitor activity of *Cassia tora* seeds which might have been due to the reason that trypsin inhibitors are heat labile and during roasting trypsin inhibitors might have reduced due to heating. Vadivel and Janardhanan (2005) studied seven species of wild legumes including *Cassia obtusifolia* and found the trypsin inhibitor activity in the legumes ranging from 13.48 to 65.43 TIU/mg proteins.
5.4.3 Tannins

Data given in Table 10 depicts the tannin content of raw and roasted Cassia tora seeds. As is clear from the Table, the raw seeds contained a higher amount of tannins when compared with roasted seeds. This might have been due to the reason that it is one of the anti-nutritional factors present in the husk portion. Since, the raw seeds are not given any treatment so higher the tannin content of Cassia tora seeds which might have been due to the reason that tannins are affected by the heat treatment.

5.5 Biological evaluation

5.5.1 Feed consumed, protein consumed

As is clear from the data given in Table 11, rats fed control diet consumed more feed as compared to rats fed test diet. The minimum feed consumption has been observed at 30% level of raw Cassia tora seeds followed by the same level of roasted seeds. Roasting resulted in an increase in the consumption of feed, however, the increase was non-significant. The feed consumption of Cassia tora might have been less due to the bitter taste of the seeds and the animals might have not preferred it. The group of rats fed 30% raw Cassia tora seeds died before completing the 28 days feeding period, thus, a lesser consumption of feed.

As given in Table 11, protein consumption was maximum in the control group followed by the group fed 10% roasted Cassia tora seeds. A significant difference is noted in the protein consumption by rats fed control diet when compared with the rats fed raw and roasted Cassia tora diet at all levels. This might have been due to the bitter taste of Cassia tora seeds. Bitterness is not affected by roasting although a slight increase is noted in the protein consumption but the increase is non-significant.
5.5.2 Weight gained

As is clear from Table 11, the rats fed control diet had maximum weight gain which might have been due to their consumption of higher amount of feed and protein. The rats in the group fed raw *Cassia tora* seeds at 20% and 30% levels and roasted seeds at 30% level suffered weight loss instead of weight gain. The weight gained by the rats fed control diet was significantly higher than the weight gained by all other groups. The groups fed *Cassia tora* diet showed less weight gain which might have been due to lesser consumption of feed and protein.

5.5.3 Feed efficiency ratio (FER) and protein efficiency ratio (PER)

Data in Table 11 reveals the Feed efficiency ratio (FER) and Protein efficiency ratio (PER) of all the animal groups. As given in the Table, maximum FER and PER was there in the control diet which might have been due to the reason that rats consumed more feed and protein and also because weight gain is maximum. FER and PER is minimum in the 30% raw *Cassia tora* which might have been due to the lesser consumption of feed and protein by these rats.

5.5.4 Mortality

Data given in Table 12 reveals the day to day mortality observed in all the animal groups. Maximum mortality rate was observed in the groups fed 30% raw and roasted *Cassia tora* seeds. All the 10 animals in each group died before completing the 28-days feeding period. However, the death rate of the animals fed 30% raw *Cassia tora* was fastest and the last animal in the group survived till the 12th day only while in the group fed roasted *Cassia tora* the animal died on 26th day. No mortality was observed in the control group. About half of the rats in the groups fed raw and roasted *Cassia tora* at 20% levels died till the end of the 28-days trial. The mortality rate in the 10% groups of raw and roasted *Cassia tora* was quite less. Figure 2 reveals the total mortality observed
in all the seven groups in the 28-days trial. The postmortem of the dead animals revealed that they died due to gastro-intestinal hemorrhages (Plate 4) and hemorrhages of lungs. Colour change from white to slightly brown was also observed in the animals fed *Cassia tora* diet at all the levels (Plate 3).

### 5.5.5 Nitrogen balance

Table 13 depicts the studies on nitrogen balance in rats fed control diet and two levels of raw and roasted *Cassia tora*. These studies could not be carried out on 30% raw and roasted *Cassia tora* groups as they died before this study. As is clear from the Table, nitrogen intake was maximum in the group of animals fed control diet. This might have been due to the reason that here protein was from casein. Lesser intake of nitrogen by group of rats fed raw and roasted *Cassia tora* might have been due to the reason that rats consumed less feed. Nitrogen intake in raw samples was less as compared to the roasted samples at both the levels which might have been due to more bitter taste of raw samples. Mankotia (2002) reported that processing of legumes increases the nitrogen intake which might have been due to the increase in palatability. Joshi (2005) reported a similar trend in the nitrogen intake of animals fed raw and roasted fenugreek seeds.

As is clear from Table 13, nitrogen excretion was more in the control diet. Higher excretion in control diet might have been due to the reason that these diets are from pure protein sources whereas other diets contain *Cassia tora* seeds. Nitrogen excretion was more in 10% level of roasted *Cassia tora* seeds which might have been due to the reason that they have higher nitrogen intake. The nitrogen excretion in raw *Cassia tora* at 10% level was almost same as that of animals fed roasted *Cassia tora* at 20% levels. The nitrogen retention was highest in the control group. Whereas, in case of raw and roasted *Cassia tora* seeds, nitrogen retention was maximum in the roasted 20% level.
5.5.6  

*In-vivo* protein digestibility characteristics of rats

5.5.6.1  

**Apparent protein digestibility (APD)**

As is clear from the data in Table 14, Apparent protein digestibility (APD) was the highest in the control group fed casein diet. The APD of raw and roasted *Cassia tora* seeds was significantly less as compared to the casein diet. The higher APD in case of control group might have been due to the reason that control diet contained pure synthetic diet and no anti-nutritional factors were there. The APD of roasted *Cassia tora* seeds at 10% and 20% levels is higher than that of raw seeds at the same levels. The increase in APD of roasted seeds might have been due to the reason that during heating anti-nutritional factors are destroyed. Joshi (2005) and Gupta (1995) reported that roasting increases the APD of fenugreek seeds and faba beans, respectively.

5.5.6.2  

**Biological value (BV)**

A glance at Table 14 shows the Biological value (BV) of rats fed *Cassia tora* seeds. As is clear from the Table, the animal group fed control diet had significantly higher biological value as compared to all other groups. Raw grains of *Cassia tora* at 10% and 20% level had lesser BV as compared to the roasted grains at the same levels. This might be due to the reason that during roasting there are losses of antinutritional factors and thus protein quality is improved.

5.5.6.3  

**True protein digestibility (TPD)**

True protein digestibility (TPD) of raw and roasted *Cassia tora* seeds is depicted in Table 14. As is clear from the Table, the maximum TPD was observed in control diet. However, the difference between the TPD of control diet and that of raw and roasted *Cassia tora* at 10% level was non-significant. Higher TPD of control diet might have been due to the reason that this diet did not contain any plant material therefore, no
antinutritional factors are there. Whereas, *Cassia tora* seeds have antinutritional factors which inhibit absorption and metabolism of different nutrients and also *Cassia tora* seeds are bitter in taste, which may have resulted in less consumption of feed.

5.5.6.4 **Net protein utilization (NPU)**

As is evident from Table 14, the casein diet showed higher Net protein utilization (NPU) as compared to all other diets. Higher NPU of control diet might have been due to the reason that this diet contained no antinutritional factors and thus is better utilized by the body and also because the feed consumption in this diet was more. Lesser NPU of raw grains might have been due to the poor digestibility and higher concentration of antinutritional factors.

5.5.6.5 **Net protein ratio (NPR)**

Data in Table 14 reveals the Net protein ratio (NPR) of *Cassia tora* seeds. As is clear from the Table NPR of control group was maximum and NPR of raw *Cassia tora* seeds at 20% level was minimum. Roasting increased NPR which might have been due to the reason that roasting leads to a decrease in antinutritional factors. Higher NPR of control diet might have been due to the reason that this diet contained no antinutritional factors. Raw grains were more bitter in taste therefore, lesser consumption and lesser NPR. Also, raw grains contain antinutritional factors which inhibit absorption and metabolism of different nutrients. The antinutrients are heat labile and reduce on roasting.

5.5.6.6 **Protein retention efficiency (PRE)**

Protein retention efficiency (PRE) of *Cassia tora* seeds is depicted in Table 14. As is clear from the Table, PRE of control diet was maximum, followed by the PRE of roasted seeds at 10% level. Lowest PRE was observed in the group fed 20% raw *Cassia tora* seeds. Raw grains of *Cassia tora* contain antinutritional factors which inhibit the absorption and metabolism of different nutrients. During roasting the heat labile antinutrients are reduced and as a result nutrient absorption increases leading to increase in PRE.
5.5.6.7 Blood glucose

A glance at Table 15 shows the blood glucose level of rats fed Cassia tora diet. Normal blood glucose of rats ranges between 47.7 mg/dl to 107 mg/dl. Raw Cassia tora seeds at 20% level had more hypoglycemic effect as compared to its 10% level. Roasting resulted in a further decrease in the blood glucose level which might have been due to the reason that, during heat processing biochemical changes take place and the absorption of nutrients is increased. Raw Cassia tora seeds had a less hypoglycemic effect as compared to the roasted seeds. This might have been due to the reason that raw seeds might have not been absorbed and metabolized properly by rats. Similar results for blood glucose levels have been reported by Joshi (2005) for fenugreek seeds. It is reported by Jang et al. (2007), Liao et al. (2007) and Yang et al. (2003) that the extracts of Cassia seeds decrease the level of blood pressure and blood glucose.

5.5.6.8 Blood cholesterol

As is clear from Table 15, consumption of Cassia tora seeds led to a decrease in blood cholesterol levels. Reduction in blood cholesterol in the rats fed raw and roasted Cassia tora seeds might have been due to the reason that Cassia tora seeds contain certain chemical constituents and are rich in fiber. During roasting an increase in fiber content was there which further decreased the blood cholesterol levels. However, decrease in cholesterol could have also been due to lesser consumption of feed by the animals. Patil et al. (2004) studied the hypolipidemic activity of Cassia tora seeds and reported that the lipid lowering effect of Cassia tora seed extract in rats may be due to inhibition of cholesterol biosynthesis and due to increased faecal bile acid excretion. The drug showed protective action as it slightly increased the HDL-cholesterol level. Chu Hua et al. (2008) reported that anthraquinone substances of Cassia obtusifolia seeds could decrease cholesterol absorption and increase its excretion,
5.5 Organoleptic characteristics of food products

5.5.1 Coffee

5.5.1.1 Colour, flavour, texture and taste

Data in Table 16 presents the scores for colour, flavour, texture and taste of coffee supplemented with raw and roasted Cassia tora seeds at 5% levels. As is clear from the Table, the addition of Cassia tora powder decreased the organoleptic characteristics of coffee. The scores for colour, flavour, texture and taste are highest for the control coffee and lowest for the coffee prepared from roasted Cassia tora seeds.

5.5.1.2 Overall acceptability

As is clear from Table 16, the overall acceptability was highest for control coffee and was least for the coffee supplemented with roasted Cassia tora powder. This might be due to the peculiar flavour of Cassia tora seeds which changed the taste of the coffee. According to Yen et al. (2002) Cassia tora seeds are used as coffee substitute, health drink and in curing several ailments.

5.5.2 Chutney

5.5.2.1 Colour, flavour, texture and taste

Data in Table 17 depicts the scores for colour, flavour, texture and taste of chutney supplemented with roasted Cassia tora seeds at 2.5% and 5% levels. As is clear from the Table, the organoleptic characteristics of chutney supplemented with Cassia tora seeds at 2.5% and 5% level are non-significantly different. The scores for colour, flavour, texture and taste are almost similar for the chutney supplemented with Cassia tora seeds at both the levels.
5.5.2.2 Overall acceptability

As is clear from Table 18, a non-significant difference was observed in the overall acceptability of *chutney* supplemented with roasted *Cassia tora* powder at 2.5% and 5% level. *Cassia tora* seeds lost their bitterness after being treated with *galgal* juice.

5.5.3 Missi roti

5.5.3.1 Colour, flavour, texture and taste

The data shown in Table 18 presents the scores for colour, flavour, texture and taste of *missi roti* supplemented with roasted *Cassia tora* seeds at 2.5% and 5% levels. As is clear from the Table, the increase in the amount of *Cassia tora* powder decreased the organoleptic characteristics of *missi roti*. The scores for colour, flavour, texture and taste were highest for the control *missi roti* and lowest for *missi roti* supplemented with *Cassia tora* seeds at 5% level. The control *missi roti* was rated as ‘liked very much’ by the judges whereas the *missi roti* supplemented with *Cassia tora* flour was rated as ‘liked moderately’.

5.5.3.2 Overall acceptability

As is clear from Table 18, the overall acceptability was highest for control *missi roti* and was least for the *missi roti* supplemented with roasted *Cassia tora* powder at 5% level. This might be due to the bitter flavour of *Cassia tora* seeds which changed the taste of the *missi roti* and the bitterness increased with the increase in level of *Cassia tora* seeds.

5.5.4 Rice flour pancake

5.5.4.1 Colour, flavour, texture and taste

The data shown in Table 19 reveals the scores for colour, flavour, texture and taste of pancake supplemented with roasted *Cassia tora* seeds at 2.5% and 5% levels. As is clear from the Table, the increase in the amount of *Cassia tora* powder decreased the
organoleptic characteristics of pancake. The scores for colour, flavour, texture and taste were highest for the control pancake and lowest for pancake supplemented with *Cassia tora* seeds at 5% level. However, there was a non-significant difference in the scores for flavour and texture of control pancake and pancake supplemented with *Cassia tora* seeds at both the levels.

### 5.5.4.2 Overall acceptability

As is clear from Table 19, the overall acceptability was highest for control pancake and was least for the pancake prepared from roasted *Cassia tora* powder at 5% level. However, there was a non-significant difference in the overall acceptability of pancake supplemented with *Cassia tora* seeds at 2.5% and 5% levels. This might be due to the bitter flavour of *Cassia tora* seeds which changed the taste of the pancake and the taste might have been less acceptable to the judges.

### 5.5.5 Bread pakora

#### 5.5.5.1 Colour, flavour, texture and taste

The data shown in Table 20 reveals the scores for colour, flavour, texture and taste of bread pakora supplemented with roasted *Cassia tora* seeds at 2.5% and 5% levels. As is clear from the Table, the organoleptic characteristics of bread pakora supplemented with 2.5% *Cassia tora* powder were the best. The scores for colour, flavour, texture and taste were highest for the bread pakora supplemented with 2.5% *Cassia tora* powder. However, the difference between control, 2.5% and 5% *Cassia tora* bread pakora was non-significant for flavour and texture and significant for colour and taste.
5.5.5.2 Overall acceptability

As is clear from Table 20, the overall acceptability was highest for bread pakora supplemented with roasted Cassia tora powder at 2.5% level. However, there was a non-significant difference in the overall acceptability of control bread pakora and bread pakora supplemented with Cassia tora seeds at 5% levels. No bitterness was observed in the bread pakora supplemented with Cassia tora seeds at both the levels.

5.5.6 Parantha

5.5.6.1 Colour, flavour, texture and taste

The data shown in Table 21 reveals the scores for colour, flavour, texture and taste of parantha supplemented with roasted Cassia tora seeds at 2.5% and 5% levels. As is clear from the Table, the scores for colour, flavour, texture and taste were highest for the control parantha and lowest for parantha supplemented with Cassia tora seeds at 5% level. However, there was a non-significant difference in the scores for flavour, texture and taste of parantha (control) and parantha supplemented with Cassia tora seeds at both the levels. The score for taste in parantha supplemented with Cassia tora seeds at 2.5% level was non-significantly higher than the score for control parantha.

5.5.6.2 Overall acceptability

As is clear from Table 21, the overall acceptability was highest for control parantha and was least for the parantha supplemented with roasted Cassia tora powder at 5% level. However, there was a non-significant difference in the overall acceptability of control parantha and parantha supplemented with Cassia tora seeds at 2.5% and 5% levels. The parantha supplemented with Cassia tora powder at both the levels was accepted by the judges.