5. SUMMARY AND CONCLUSION

5.1 Development of functional foods for appetite

5.1.1 Five appetising foods namely, ginger beverage, ajowan beverage, karpurvalli beverage, ajowan munch and karpurvalli soup mix have been developed.

5.1.2 Five appetising foods namely, ginger beverage, ajowan beverage, karpurvalli beverage, ajowan munch and karpurvalli soup mix developed have been optimized for ingredient composition using a statistical design software (SDS) ‘design expert’.

5.1.3 Ginger beverage, a ready-to-drink appetizer was optimized with 12% ginger juice with fifteen combinations drawn from SDS and the optimized beverage had 0.21% acidity, 3.4 pH, 10.5°Brix TSS and 8.0mg% of principal component gingerol.

5.1.4 Ajowan beverage, a ready-to-drink appetizer was optimized with 0.16% ajowan powder with twenty combinations drawn from SDS and the optimized beverage had 0.24% acidity, 3.5 pH, 10.5°Brix TSS and 0.0093mg% of principal component, thymol.

5.1.5 Karpurvalli beverage, a ready-to-drink appetizer was optimized with 12% karpurvalli juice with fifteen combinations drawn from SDS and
the optimized beverage had 0.27% acidity, 3.8 pH, 10.5°Brix TSS and 0.0561µg% of principal component, carvacrol.

5.1.6 **Ginger beverage, ajowan beverage, karpurvalli beverage**
methodology of in pack pasteurization processing was optimized for these products.

5.1.7 **Ajowan munch**, a ready-to-eat appetizer has been developed with 4.6% ajowan powder with twenty combinations drawn from SDS and the optimized product had 7.1% protein, 8.6% fat, 2.9% ash, 6.2% crude fibre, 65.5% carbohydrates and 0.28mg% of principal component, thymol.

5.1.8 **Karpurvalli soup mix**, a ready-to-reconstitute convenience mix has been optimized with 6.4% dehydrated karpurvalli leaves powder with thirteen experimental combinations drawn from SDS and the optimized product had 19.1% protein, 6.3% fat, 8.3% ash, 5.2% crude fibre, 54.4% carbohydrates and 0.11mg% of principal component, carvacrol.

5.1.9 The **ginger beverage, ajowan beverage, karpurvalli beverage**
bottled, **ajowan munch packed in** metalised polyester pouch and **karpurvalli soup mix** packed in a laminated pouch stored at 5, 18-33 and 37°C were analyzed periodically for storage stability characteristics
5.2 Establishing the storage stability and shelf life of the developed products.

5.2.1 Ginger beverage packed in PP bottles had shelf life of six months at ambient conditions based on the chemical, sensory and microbial analysis during storage. The vitamin C content reduced after pasteurization by 13.4% and further during storage decreased by 25.4, 39.6 and 64.2% at 5°C, RT and 37°C, respectively while the gingerol content losses were temperature dependent and found to be 15.8, 32.3 and 56.3% at 5°C, RT and 37°C, respectively after six months of storage.

5.2.2 Ginger beverage irradiated with 1, 2 and 3KGy dose showed lower antioxidant activity of 8.4% for 1KGy, 8.3 for 2KGy and 8.0% for 3KGy as compared to that of control (10.3%).

5.2.3 Ginger beverage irradiated with 1, 2 and 3KGy dose showed higher reduction in gingerol content 21.17, 36.92 & 61.87%; 21.80, 44.44 & 73.32%; 23.28, 49.16, & 75.0% compared to that of control 13.17, 29.62 & 54.70% at 5°C, RT and 37°C, respectively which clearly brought out the temperature effect and by considering the storage changes in irradiated samples, normal processing without irradiation is more suitable for ginger beverage.
5.2.4 In Ginger beverage packed in PP pouch; PP bottle and glass bottle, the initial acidity of 0.21-0.22% in all the three packaging materials increased to 0.43 -0.5% at 37°C and 0.41-0.44% at RT after six months while beverages stored at 5°C showed moderate increase in acidity. The initial browning index of 0.045 for ginger beverage packed in PP pouch increased to 0.095 and 0.106 at RT and 37°C storage whereas for PP and glass bottled beverages the browning index of 0.041 increased to 0.087 and 0.091 - 0.093 at RT and 37°C storage for six months. Based on the sensory parameters, the ginger beverage had a shelf life of four months in PP pouch and six months in PP and glass bottles at ambient conditions.

5.2.5 Ajowan beverage packed in PP bottle had a shelf life of six months at ambient conditions. The storage changes showed good acceptance, safety and chemical changes of lower magnitude.

5.2.6 Karpurvalli leaves had 60-69% DPPH free radical scavenging activity indicating the antioxidant potential, total carotenoids 269 µg/g and dietary fibre content of 3.26% with soluble fibre content of 2.32% indicating the functional importance.

5.2.7 Karpurvalli leaves had 207.3mg% Calcium, 150.4mg% Magnesium and 98.92mg% Potassium as the major minerals followed by Phosphorous and Sodium. Other minerals present in trace amounts in descending order were copper, iron, zinc and manganese.
5.2.8 **Karpurvalli leaves** had total catechins to the level of 38.2ppb with equal distribution of 12-13 ppb each epigallocatechin, epigallocatechin gallate and gallocatechin gallate. This is the first report on the catechins on karpurvalli leaves.

5.2.9 In **karpurvalli leaves** ether volatiles were 74.41mg%, while in stalk and stem it were 14.385 and 9.475mg%, respectively. The principal compound carvacrol was present maximum in leaves (22.8µg %) as compared in stalk and stem with very low levels of 1 to 1.2 µg%, thereby leaves have been used in the study.

5.2.10 **Karpurvalli beverage** packed in PP bottle showed an increase in acidity and browning index to 0.52-0.62% and 0.090-0.095; while overall acceptability of 8.50 reduced to 7.64 and 6.85, after six months at RT and 37°C, respectively. The microbial stability of karpurvalli beverage for six months and acceptable sensory properties established the shelf life of six months at ambient conditions.

5.2.11 **Karpurvalli beverage** irradiated with 1, 2 and 3KGy dose showed higher reduction in **carvacrol content** 29.31%, 27.23% and 55.76%; 29.25, 47.71 & 54.95%; 19.06, 38.16 and 64.20% % compared to that of control 11.36, 33.47 and 57.67% at 5°C, RT and 37°C, respectively which clearly brought out the temperature effect and by considering the
storage changes in irradiated samples, normal processing without irradiation is more suitable for karpurvalli beverage.

5.2.12 In the Karpurvalli beverage packed in PP pouch; PP bottle and glass bottle, the parameters such as acidity, browning, pH, TSS and overall acceptability were studied and it was found that the karpurvalli beverage was stable during storage and had a shelf life of four months in PP pouch and six months in PP and glass bottles at ambient conditions.

5.2.13 Ajowan munch stored in laminated pouch showed increase in acidity from 0.48% to 0.83% and 0.89% at RT and 37°C while the thiobarbituric acid value of 0.03 increased to 0.20 & 0.28 at RT & 37°C after eight months storage. However, the appetizer was very well accepted even after eight months storage; hence, the shelf life was established up to eight months at ambient conditions.

5.2.14 The karpurvalli leaves blanching conditions were optimized with 0.2 % MgO, 0.1% NaHCO₃ and 0.2 % KMS in blanching liquor and blanching 30-60 seconds. This optimized blanching treatment was further improved wherein the hot water blanching was followed by cold water dipping and drying at 60°C for six hours. This treatment improved the chlorophyll retention.
5.2.15 **Karpurvalli soup mix** stored in laminated pouch showed an increase in initial acidity of 0.042% to 0.60-0.62% while the TBA value of 0.2 increased to 0.40 to 0.46 mg/kg after 8 months storage at RT and 37°C. However, the OAA score of 7.7 decreased to 6.85 after six month storage at 37°C which further reduced to below average after eight months; hence product was stable up to six months at ambient conditions.

5.3 **Evaluation of the functional foods developed**

5.3.1 Animal study: **Ginger beverage, ajowan beverage and karpurvalli beverage** administered rats shown a decrease in the plasma leptin level by 8.06, 4.62 and 10.83% respectively, when compared to their fasting leptin levels. Thus it was encouraging result that the leptin levels of rats decreased after consumption of the appetizers, indicating their appetizing effect. The reductions in leptin levels were statistically significant \( p< 0.05 \) in groups administered with **ginger beverage and karpurvalli beverage**.

5.3.2 The group of rats administered with **ginger beverage, ajowan beverage, and karpurvalli beverage** continuously for ten days resulted in increase in weight by 11.20, 9.57 and 13.26%, respectively over the trial period while in control group it was 7.68%. On the other hand, food consumption pattern revealed by the quantity of leftover food showed that the group administered ginger beverage, ajowan beverage and karpurvalli beverage had 30.53% & 31.13% leftover,
34.0% & 28.07% leftover and 22.00% & 26.28% leftover for 1st five days and later five days, respectively; while the control group had 43.11 & 41.43% leftover for 1st 5 days and the later five days. Thus the study concluded confirming that the three beverages had appetite improving effect in the order Karpurvalli beverage > ginger beverage > ajowan beverage.

5.3.3 In human study, thirty two volunteers form DFRL participated in study after giving the written consent. These volunteers were divided in the four groups as Control group administered with placebo beverage, while group 1, 2 & 3 administered with karpurvalli beverage containing 12, 18 and 24% karpurvalli juice, respectively. The average age of volunteers in the four groups ranged from 31.38 ± 6.25 to 33.13±5.49, while the average BMI ranged between 20.33 and 22.1. The average body fat, body water and body muscle among the four groups ranged between 23.30 to 26.46%, 50.51 to 52.69% and 38.0 to39.69%, respectively.

5.3.4 The post prandial plasma leptin levels of groups administered with 12 and 18 % karpurvalli juice showed reductions in the leptin level while the leptin level increased in group administered with placebo and beverage containing 24% karpurvalli juice. The difference was significant (p<0.05) only with the group administered with beverage containing 24% karpurvalli juice which indicated satiating effect as a result of increase in leptin level.
5.3.5 The subjective evaluation study for *Karpurvalli beverage* containing 12%, 18% and 24% *karpurvalli juice* revealed that, in the groups administered with beverages containing 12 and 18% karpurvalli juice as well as the control group the appetite rating increased after consumption of beverage. But the control group showed a marginal increase while there was considerable increase in rating of group 1 and 2. However, at higher concentration i.e. group 3 with beverages containing 24% karpurvalli juice, the appetite rating decreased probably because of satiety feeling with increased karpurvalli juice concentration.