CHAPTER 5

SUMMARY AND CONCLUSIONS

Nutritional care of elderly has received little attention despite the fact that preconditions for the development of malnutrition increases with enhancing age, therefore, ageing is an issue of global concern of this hour. Ageing initiates various physiological, psychological, social and economic changes in one’s life. People’s food choices change during this time and their appetite also declines gradually consequently deteriorating their nutritional status. Demand of healthy and nutritious foods is increasing day by day. Fortification of food items incorporating either food ingredients or fortificants is the most promising method to combat this demand and to enhance supply of healthy and nutritious food. RSM is a novel technique, is used to produce optimal conditions for different food items. Regular intake of healthy food items may improve the nutritional and health status of under nourished elderly. Therefore, formulation of healthy and nutritious food is the dire need of the hour which can be helpful in preventing health related problems and in promoting health. In this regard, present study was an attempt (i) to develop and standardize a range of nutritious geriatric food products by using food and fortificant nutrients or premixes, (ii) to assess their acceptability among geriatric people, (iii) to conduct nutritional, chemical and shelf life analysis of standardized products and (iv) to study the impact of selected geriatric food on nutritional status of elderly.

The study was undertaken in three phases, (i) nutritional and health survey for identification of needs, (ii) formulation of geriatric food products and (iii) intervention trial. Various needs of older adults were identified in first phase of the study without which food formulation was not possible. Hundred elderly people (aged ≥65 years) who gave written informed consent were selected from 10 different parts of Kota using random cluster sampling technique. General information of subjects was collected using self designed and pre tested questionnaire. Geriatric needs pertaining to food preparation were identified using two checklists, (i) barriers affecting food choices of elderly and (ii) factors affecting selection of food items of elderly, which were modified according to the requirements of local area. Health and lifestyle related problems of participants were identified using health assessment checklist. Nutritional status of elderly was evaluated by anthropometry (weight, height, BMI, MUAC and
Summary and Conclusions

CC), dietary assessment (24 hour dietary recall) and using MNA. Energy and other nutrients intake of elderly were assessed and compared with the WHO recommendations. Data was analysed using SPSS © version 20.0. Karl Pearson’s correlation of coefficient and independent sample t test were calculated and significance was checked at 5% level.

Geriatric food products, in accordance with the needs assessment, were formulated in Banasthali Vidyapith in eight categories (1) general nutrient dense products, (2) electrolyte replacement supplements, (3) high protein foods (food products containing high biological value protein), (4) low calorie foods, (5) high fibre foods, (6) diabetic foods, (7) antihypertensive foods and (8) controlled fat food products. Five types of foods, i.e., (i) appetizers, (ii) starters, (iii) extruded and precooked foods, (iv) ready to serve (RTS) beverages and (v) instant or convenience foods were developed in each of eight categories. Total 120 recipes were formulated in this study according to FSSAI regulations incorporating various health promoting ingredients. Various nutrients of each recipe were calculated. Among them 40 recipes (8 categories × 5 type of food × 1 recipe) were selected as best recipes using organoleptic evaluation which was carried out using 9 point hedonic rating scale and 5 point composite rating scale. Process optimization was applied on six selected recipes GND-sattu-Ins (general nutrient dense), HP-instant kheer mix-Ins (high protein), HF-high fibre mix-Ins (high fibre), DI-vegetable cereal mix-Ins (diabetic), AN-chutney mix-Ins (antihypertensive) and CF-khakhra-Ins (controlled fat) using response surface methodology and central composite rotatable design. Design Expert (9.0) software was used for optimization. Two process variables were selected for AN-chutney mix-Ins resulting in thirteen sample combinations. Three process variables were chosen for other 5 recipes for optimization process resulting twenty sample combinations for experimentation. Each sample was prepared in food laboratory and different responses were estimated. Collected data was then subjected to second order polynomial regression analysis, ANOVA and lack of fit test. Significance was determined at 5% level. Response surfaces or surface plots were generated for each response variable. Numerical optimization technique was used for simultaneous optimization of the multiple responses in which desired goals were chosen for each factor and responses. Seven instant foods were fortified with different fortificants (i.e., vitamin A, B₁, B₂, B₃, D, folic acid, calcium or iron) according to
their upper levels set by National Academy of Sciences. Selected eight instant foods were undertaken for physico-chemical, microbiological and shelf life analysis. Best selected forty food recipes were evaluated by 100 older adults for their acceptability using 9 point hedonic rating scale. Descriptive statistics and paired t test were used for data analysis.

Intervention trial was conducted on three groups of elderly people (aged ≥65 years) of Kota (i) healthy elderly, (ii) elderly with constipation and (iii) elderly with hypertension by supplementing them (i) GND-sattu-Ins, (ii) HF-high fibre mix-Ins and (iii) AN-chutney mix-Ins respectively. It was a cross sectional non randomized study which was carried out for 3 months. Each group had 30 subjects who were selected after taking written informed consent. Data pertaining to general information, anthropometry, dietary assessment, nutritional assessment using MNA and quality of life of subjects (using constipation scoring system for elderly with constipation and MINICHAL tool for elderly with hypertension) were collected before and after supplementation and analysed using SPSS.

Results showed a significant difference in mean age of men (75.5 years) and women (72.1 years). Majority of subjects were lacto vegetarian (81%). Losses related to teeth, appetite and vision were reported by many participants. Being in pain and feeling tired or weak were the factors that negatively affected the food choices of elderly. Joint pain, hypertension and constipation were commonly reported by subjects. A significant difference was found in height, weight and BMI of men and women. Weight loss was found more in women as compared to men. Energy and nutrients intakes of most of the elderly were lower than the RNI. MNA indicated that nutritional status of women was poor as compared to men. The identified needs of geriatric people were low cost, easy to cook, easy to chew, healthy and disease specific food items that also have high sensory appeal. They also needed appetite enhancers and precooked or convenience foods due to appetite loss and their inability to prepare food items at home.

Different nutrients were calculated for the various food items which indicated that all 120 recipes fulfilled the different nutritional claims desired by FSSAI. Organoleptic analysis indicated that mean hedonic rating score of GND-khandvi-Sta, GND-smileys-Pre and GND-thandai-Bev was 8.8 whereas the mean hedonic rating score of GND-cumin munch-Ap and GND-sattu-Ins was 8.0 and 8.2 respectively.
These food items were liked very much by the semi trained panel. ERS-fruit mocktail-Sta received highest possible composite rating score 5 for its colour and consistency by all panel members. Most of the testees gave highest possible hedonic rating score 9 to ERS-mix fruit panna-Ap (n=8), ERS-mix fruit yoghurt-Pre (n=9), ERS-apple tea-Bev (n=13) and ERS-mango mint squash-Ins (n=12). Different organoleptic attributes of these products were rated good by the panel members. Mean hedonic rating scores of HP-ajwain much-Ap (8.7), HP-khandvi-Sta (8.3), HP-smileys-Pre (8.9), HP-thandai-Bev (8.9) and HP-instant kheer mix-Ins (8.4) were liked very much or extremely. All testees gave maximum possible composite rating score 5 to appearance, colour, consistency and after taste of HP-thandai-Bev. Composite rating scores indicated that different organoleptic attributes of the LC-amla panna-AP, LC-beetroot kanji with fruits-Sta, LC-tangy tango mocktail-Pre, LC-bottle gourd cucumber juice-Bev and LC-spinach garlic punch-Ins were considered good by the semi trained panel. Mean hedonic rating scores of these products were 8.7, 8.1, 8.4, 8.7 and 8.3 respectively. HF-cumin munch-Ap obtained highest possible composite rating score 5 for its appearance and colour whereas HF-dhokla-Sta got this score for its taste and after taste. HF-smileys 1-Pre and reconstituted HF-high fibre mix-Ins received highest possible hedonic rating score 9 by 13 testees. Among RTS beverages HF-high fibre drink-Bev received highest mean hedonic rating score (8.0). These food items were liked very much by testees and they were selected as best food items in high fibre category. DI-vegetable soup-Ap and DI-khandvi-Sta had 7.9 and 7.6 mean hedonic rating scores respectively and they were liked moderately by the panel members. Mean hedonic rating scores of DI-pasta 1-Pre and reconstituted DI-vegetable cereal mix-Ins were 8.8; DI-fruit GLV punch-Bev was 8.4 illustrating that these products were liked very much by the testees. Sensory attributes of AN-cumin munch-Ap, AN-khandvi-Sta, AN-smileys-Pre, AN-cucumber punch-Bev and AN-chutney mix-Ins were considered good by the panelists and they obtained 8.4, 7.9, 8.2, 8.8 and 8.6 as mean hedonic rating scores respectively. Panel members gave highest possible composite rating score 5 to appearance of AN-cumin munch-Ap and AN-khandvi-Sta. Most of the panel members gave highest possible hedonic rating score 9 to CF-cumin munch-Ap (n=11), CF-dhokla-Sta (n=11), CF-vermicelli 1-Pre (n=9) and CF-mix juice-Bev (n=12) whereas reconstituted CF-khakhra-Ins obtained a score of 8 by 10 panelists. All the products were liked very much by semi trained panel.
Various optimal solutions were generated by Design Expert (9.0) software for six recipes from which one solution was selected as optimized solution on the basis of highest desirability. Desired goals for each response were met in each process optimization. The optimum GND-sattu-Ins had 22.0 g soybean, 7.0 hours germination time and 7.0 g drumstick leaves with 362.34 kcal energy, 16.94 g protein, 380.11 mg calcium and 90.76 score for overall acceptability. The optimal solution of HP-instant kheer mix-Ins had 12.0 g cowpea, 5.0 g malted wheat flour and 4.0 hours soaking time with 10.27 g protein, 0.76 g fibre and 8.05 score for overall acceptability. The optimized HF-high fibre mix-Ins contained 7.0 g colocasia leaves, 30.0 g bengal gram, 10.0 hours germination time with 291.59 kcal energy, 3.50 g fibre, 1583.85 mcg β-carotene and 88.34 score of overall acceptability. The optimum condition for DI-vegetable cereal was 8.0 g fenugreek seeds, 8.0 hours soaking time and 5.0 g Gymnema sylvestre with 0.48 g fat, 3.01 g crude fibre, 29.84 g carbohydrate and overall acceptability score of 89.17. For AN-chutney mix-Ins the optimum solution was 2.0 g black cumin seeds and 0.2 g Rauwolfia serpentina with 11.35 mg sodium, 4.29 g fibre and 7.90 score for overall acceptability. The optimized CF-khakhra-Ins contained 3.0 g flax seeds, 10.0 hour soaking time and 7.0 g oregano leaves with 1.01 g fibre, 1.90 g fat, 8.89 mg vitamin C and 92.58 score for overall acceptability.

Alcoholic acidity of different food items (freshly prepared as well as stored for 30 days) was within the limits specified by FSSAI. All the food items were nutritionally adequate. Addition of fortificants enhanced the nutrient density of formulated food items. No significant difference was found in total plate count and coliform count of both unfortified and fortified GND-sattu-Ins during storage. Microbial content was absent in freshly made and stored ERS-mango mint squash-Ins. Yeast and mould counts were absent throughout the storage in HP-instant kheer mix-Ins. Change in total plate count of LC-spinach garlic punch-Ins was not significant. Mean yeast and mould count decreased in HF-high fibre mix-Ins and DI-vegetable cereal mix-Ins (both without and with fortificant) indicating the presence of anti fungal agent in these recipes. Microbial contents of AN-chutney mix-Ins increased with storage but the change was not significant. Coliform count of unfortified CF-khakhra-Ins reduced with increasing storage whereas other counts increased but the difference was non significant. Shelf life evaluation (organoleptic analysis) of different recipes illustrated that different sensory attributes of both unfortified and
fortified food items (freshly made and stored) were considered good by the panel members. Standardized recipes were either liked moderately or liked very much by the older adults. All the formulated products were appreciated by the study participants.

Supplementation of GND-sattu-Ins significantly changed (improved) the dietary intake and nutritional status of healthy elderly. Regular intake of HF-high fibre mix-Ins for 3 months not only improved the nutrients intake and nutritional status of elderly with constipation but also enhanced their quality of life by providing relief from constipation. Supplementation of AN-chutney mix-Ins reduced the MINICHAL scores in post intervention indicating better quality of life. Dietary intake and nutritional status of elderly with hypertension were also improved with supplementation.

Following conclusions were drawn in this study based on above mentioned objectives and results.

1. Most of the elderly were either at risk of malnutrition or already malnourished.
2. The standardized geriatric food products are suitable to meet elderly requirements and adhered to theoretical standards and specifications.
3. All geriatric foods have desirable organoleptic qualities as judged by semi trained panel.
4. The formulated geriatric foods found a high acceptability among the elderly subjects.
5. The nutrient content of the standardized instant foods is upto the mark for respective categories with fortificant added foods being higher in the enriched nutrients.
6. The acceptability of with and without fortificant geriatric foods is similar.
7. The standardized geriatric foods have the levels of pH and alcoholic acidity with in acceptable limits.
8. All the foods can be stored for one month without organoleptic and microbiological deterioration.
9. Soybean and drumstick leaves powder added sattu is rich source of protein, iron and calcium and is effective in enhancing nutrient intake and maintaining the nutritional status of the elderly.

10. High fibre mix containing bengal gram and colocasia leaves powder is rich in fibre and can be effectively used for relieving constipation in the aged people.

11. Chutney mix with black cumin seeds and Rauwolfia serpentine have therapeutic potential and can significantly bring down the elevated blood pressure values in elderly on regular consumption.

APPLICATIONS/ IMPLICATIONS

1. Formulated food items can be added as food add-ons in diet of elderly without altering their regular daily diet.

2. Regular consumption of these food items would be helpful in prevention of under nutrition in elderly.

3. Use of different food processing techniques (i.e., soaking, blanching, germination, drying, malting) and food formulation techniques (i.e., fermentation, roasting) enhances the nutrient density of geriatric health promoting ingredients. These techniques facilitate organic processing of ingredients and can minimize the risk of adverse health effects of processed foods.

4. The formulated extruded and precooked food items and instant food products will be convenient for aged people. These geriatric food products will save time, money and labour and will also provide hygienic, nutritious food products of standard quality with enhanced shelf life at reasonable cost.

5. This work would help policy makers and other health specialists for upliftment of nutritional and health status of elderly. These diversified and fortified foods will reinforce and support various health improvement programmes.

6. Incorporation of developed geriatric nutritious foods in nutritional programmes such as “meals on wheels” can be regarded as part of a broader and integrated approach to prevent micronutrient malnutrition and enhanced quality of life.
7. These formulated food products can be used in old age homes, geriatric ward of hospitals and in long term care units. These can be a part of an effective strategy to overcome health and associated nutritional hazards in this special population and can appear to be a very effective method of nutrition delivery.

8. It will help in promotion of informed food choices and thereby aid in the primary prevention of malnutrition and associated diseases.

RECOMMENDATIONS

1. Awareness campaigns related to healthy food choices should be arranged periodically as a part of welfare programme.

2. Informal and educational programme to highlight the importance of geriatric health promoting ingredients in diet should be an integral part of diet counselling in NGOs, geriatric clinics, health centres and hospitals.

3. The technologies developed in this endeavour may be transferred to entrepreneurs for large and small scale adoptions. So the food items can reach with larger number of elderly. These efforts could also be an additional source of income generation, employment and exports of these items will provide a viable alternative to imported food supplies to treat malnutrition.

4. Value added food items (appetizers, starters, precooked or RTS beverages) should be promoted in order to ensure the consumption of different nutrients and fulfilment of RNI of these nutrients in elderly.

5. Popularization of geriatric foods based on simple, locally available, inexpensive foods for specific conditions of elderly has to be taken up.

6. Promotional activities can be carried out for physical activities, yoga, exercise and medical camps to enhance the well being of elderly.

LIMITATIONS

1. Age group of older adults was ≥65 years in this study.

2. Need identification survey was done on small group of elderly.

3. The quality of raw and processed functional ingredients was not analysed due to time constraints.
4. In depth study of physico-chemical and microbial characteristics of each formulated recipe was not carried out due to large number of recipes.

5. Number of participants for intervention trial was very small.

FUTURE SCOPE

1. Chemical and biochemical changes of food items in various packaging materials can be identified.

2. Storage study of formulated products in the present investigation can be continued for enhancing shelf life using different packaging materials.

3. Effect of supplementation of different food items on nutritional status of elderly can be studied. Clinical trials of food items can be conducted for combating various specific nutrition related problems.