CHAPTER 4

Objective 3: Preparation of biscuits from malted wheat and bengal gram mix with or without green leafy powder and determination of acceptability of these biscuits in comparison to that of biscuits prepared from raw mix

Introduction

Germination of grains, a step in the process of malting, has been reported to enhance and improve the quality of grain nutrients (Dalby and Tsai 1976, Babu 1976, Ganesh Kumar and Venkataraman 1978, Wu 1982, Krishnamurthy and Venkataraman 1983). The malted grains have been utilized mainly in the preparation of weaning foods (Brandtzaeg et al 1981, Malleshi and Desikachar 1982) but no attempts have been made to use the malted grains in preparation of snacks for school going children, pregnant and lactating women and geriatrics.

Biscuit as a common snack

Blenford (1983) had defined snack as a small processed food item, sweet or savoury, having adequate shelf life (in excess of six weeks without refrigeration, etc.), and ready to be eaten (as is or after minimal preparation, e.g., addition of boiling water) between, during or in place of meals.

More recently, Delroy (1985) has stated that snack foods are not designed to be alternatives for the three main meals a day and their nutrient contribution should be viewed in that light. Snack foods, according to him, should be convenient to eat involving no preparation time or effort by the consumer, and have an important role in social gatherings.

Morgan (1983) had emphasized the importance of snacking because snacks contribute to the energy and nutrient intake of an individual. According to the 1977 to '78 Nationwide Food Consumption Survey (NFCS) in USA, snacks provided 20% of the food energy, 12% of the average protein intake, 16% of the fat intake and 25% of the daily carbohydrate intake. On an average, the snackers received from snacks 14% of their daily iron intake, 21% of their magnesium and calcium intakes, 13 to 14% of their vitamin A, thiamin, preformed niacin, vitamin B_6, and 16 to 17% of their vitamin C and riboflavin intakes. The survey indicated that for 3 to 5 year old children, the foods most frequently eaten as snacks, in descending order of frequency, were bakery products, milk, soft drinks, fruit, milk desserts, candy and bread. For 6 to 11 year olds also, the bakery products topped the list of the snacks in order of preference.

In a survey conducted to find out snacking habit, Gillispie (1983) reported that 73% of the respondents had a snack in the morning, afternoon or evening. While only 27% of the respondents never or almost never had a snack at any time of the day. Similar results have been reported by Morgan (1983) that 59 to 70% of the US children and teenagers had at least one snack during the day. These findings suggest that snacking is a common practice especially among the younger age groups.

Pasricha et al (1973) had tested the popularity of a few snacks such as rice porridge, ragina, biscuits and wheat germ ladoo. Biscuits were found to be the most popular snack among children. The authors emphasized the need to use locally available foods in the formulation of a recipe because the locally available foods being familiar are most acceptable as they fit in with the local food habits and traditions as well as the economic status of the people.

Menon et al (1980) reported that over 80% of women gave about 5 to 10 paisa (0.008 to 0.012 $) daily to their children to buy snacks from the local village shops. Among those that were bought in the village shops, biscuits were the most popular ones. Gopujkar et al (1984) observed that the biscuits available at the village shops were of poor nutritional quality. They suggested that if the quality and nutritive value of biscuits is improved and the biscuits are made available at subsidised rates to pregnant and nursing women and to infants and children of the poor segments, their nutritional status can be improved.

Warren and his coworkers (1983) have opined that products like cookies and crackers were widely consumed and had relatively long shelf life and good eating qualities. Long shelf life makes large scale production and distribution possible and good eating quality makes cookies attractive for protein fortification for child feeding programmes, the elderly and low income market segments. For protein fortification the authors suggested that both plant and animal proteins combined or individually might be used to fortify the cookies, crackers and snacks. They proposed that cereals used in cookies and crackers be supplemented with legumes, nuts and oilseeds to enhance protein quality of the product. Lorenz (1983) had also made similar suggestions.

Many investigators have used different combinations of cereals, legumes and nuts to produce protein rich biscuits and crackers. For example, Kahn and Penfield (1983) prepared crackers containing 25, 40, 55 and 70% whole grain triticale flour and demonstrated that triticale flour could be used to produce acceptable, protein rich crackers. Rao et al (1984) formulated a recipe for protein rich biscuits from jowar, soya bean and skim milk powder. Sarode et al (1983) explored the possibility of using combinations of sorghum flour and wheat flour in biscuit preparation. Hernandez and Sotelo (1984) supplemented wheat flour with bengal gram or cheese whey in preparation of two kinds of cookies. Prabhavathi et al (1973) and Prabhavathi et al (1974) had used protein rich flours such as groundnut, soya bean, wheat germ and pea with wheat flour in preparation of protein rich biscuits. Ranhotra (1980) had used a combination of cake flour and soya flour to increase the protein content of the cookies whereas Dreher and Patik (1984) had used whole navy bean flour and navy bean protein rich flour with wheat flour in the preparation of cookies. Diwan et al (1982) had used green gram and black gram flours with wheat flour in the preparation of biscuits.

Basic ingredients needed for biscuit preparation

Flour : It has been reported that wheat is the only grain which yields a flour capable of being made into a low density baked product which is constructed of fine uniform cells or vescicles and has a soft elastic texture (Matz and Matz 1978). However, a blend of plain and whole meal flours has been used in preparation of biscuits. The plain flour used in making biscuits was enriched with calcium, iron and vitamins (Watson 1984).

Shekara and Shurpalekar (1984) conducted laboratory studies on the utilization of non-wheat flours in biscuit making. They reported that biscuits of acceptable quality could be prepared by substituting wheat flour up to 20% with cassava flour or up to 30% with potato flour. The biscuits prepared using a 60:20:20 blend of wheat, cassava and potato flours were also found to be acceptable. The use of potato flour was believed to help in overcoming the undesirable effect of cassava flour such as fragility, mouthfeel and colour.

Shortening : Fat is used in baked products to make them more palatable. The characteristics desired of a shortening as listed by Smith (1972) are (a) good creaming quality, (b) high resistance to oxidative rancidity, (c) high melting point and (d) a 'bland' or 'good' flavour. Previously, oils and butter were used in baking but with the advent of hydrogenation of liquid oils, hydrogenated fats have come into use.

During mixing, the fat encourages the entrapment and retention of considerable quantities of air and thus contributes to the texture of the baked product. Other ingredients being constant, increase in shortening gives biscuits of reduced thickness and increased spread in the oven (Smith 1972).

Sweetners : According to Hickenbottom (1977) biscuits without sweetness would be akin to terriyaki sauce without soya sauce. The presence of sweetners in biscuits significantly affect the texture, appearance and flavour of the product. Smith (1972) had enumerated the contributions of sugar to the baked product, according to him (a) it imparts sweetness, (b) increases tenderness, (c) contributes to volume, (d) develops a pleasing crust colour, (e) creates a proper balance between liquids and solids responsible for contour, (f) acts as a vehicle for other flavours, (g) assists the retention of moisture and (h) gives an attractive finish.

Various types of sweetners that have been used in biscuit making include cane and beet derived sugars, corn sweetners, malt and honey. Although not widely, brown or soft sugars have also been used in biscuit making.

Water : Pyler (1973) pointed out that proportion of water used in relation to flour affects the characteristics of the dough such as consistency, pliability, extensibility and stickiness which ultimately are reflected in the general characteristics of the product.

Matz and Matz in 1978 demonstrated that the quality of water used as an ingredient can also have an effect on bakery products because the amount and type of dissolved minerals and organic substances present in the water can affect the flavour, colour and physical attributes of the finished baked products.

Leavening agents : In biscuit making, carbon dioxide is of great importance as it helps to texturise the crumb texture. Baking powder which is a mixture of sodium bicarbonate and an acid powder in the approximate ratio of 1:2 is commonly used as the leavening agent.

Baking procedures

Mixing : In the context of biscuit doughs, the term mixing covers the following distinct operations (a) the blending together of ingredients to form a uniform mass, (b) the kneading of the mass to impart development of gluten from flour proteins in the presence of water, (c) the build up of temperature as a result of work imparted and (d) aeration of a mass to give a lower density. Manley (1983) opined that the quality of a dough is determined by the recipe, the nature of the ingredients used and the degree to which these ingredients are mixed together.

Baking : Every baking process depends upon heat transfer from a hot source to the product being baked. There are three means of heat transfer - conduction, convention and radiation. High frequency - both induction and dielectric methods have also been used in biscuit making (Whitley 1971). In an ordinary tunnel oven the greater part of the total heat is transferred to the dough pieces by radiation and a small amount by conduction and convention (Smith 1972).

Within the oven, dough pieces undergo two types of changes, physical and chemical (Smith 1972, Manley 1983). Physical changes include (a) formation of a film crust on the dough, (b) melting of the fat in the dough, (c) gas expansion, (d) water converted to steam and (e) escape of carbon dioxide, other gases and steam. Chemical changes include (a) gas formation, (b) starch gelatinisation (Lineback and Wongsrikasem 1980, Hoseney et al 1983), (c) protein changes and (d) caramelisation of sugar and dextrinisation.

Cooling : Biscuits on emergence from the oven are very hot, very soft and usually very moist. Because of the relatively high moisture content, the starch remains in the form of gelatinous paste, dextrins and sugars remain in partial solution and the shortening is present as an oil rather than as a fat. So almost every ingredient is in an 'unset' state. But on cooling because of loss of some moisture and internal heat, the biscuits become dry and hard (Smith 1972).

Improvement of the nutritive value of biscuit through
Use of cereal-pulse combination : Cereal proteins are known to be deficient in lysine and threonine while pulse proteins are deficient in tryptophan and methionine (Swaminathan 1979). Steinke and Hopkins (1983) have opined that legume proteins are excellent

sources to balance the amino acid content of traditional cereal foods, such as corn, oats, rice and wheat and hence can be used to supplement the cereal proteins. But the amount of legume protein needed to supplement the cereal protein and/or limiting amino acids would vary depending on the amino acid content of the cereal. Many investigators have shown that the protein of cereal-pulse mixes is higher than that of the individual proteins (Shehata and Fryer 1970, Chatterjee and Abrol 1975, Narayanaswamy et al 1975, Chandrasekharappa 1979, Pushpamma and Devi 1979, Juneja et al 1980).

Use of malted grains : According to Whyte (1973) sprouted cereals can be used in the preparation of various breakfast items, party dishes, salads, soups, casseroles, pasta products, breads, biscuits and muffins. Malted grains have been used in the preparation of weaning foods (Brandtzaeg et al 1981, Malleshi and Desikachar 1982, Gopaldas et al 1982), malt extracts (Hynes 1983), malted foods (Korula et al 1961, Vaidehi 1983), confectionaries and breakfast cereals (Haynes 1983). Wang and Fields (1978) used germinated corn in the preparation of tortillas and Ranhotra et al (1977) used germinated wheat flour in bread preparation. Recently, Vaidehi et al (1986) have used ragi malt in the preparation of biscuits.

Addition of green leafy vegetables : Rao et al (1980), Smith (1982) and Katiyar et al (1985) found that green leafy vegetables are rich sources of minerals and vitamins and suggested that these should form an important component of the diets. The beneficial effects of supplementation of greens to various diets have been demonstrated by a number of investigators. The improvement in the protein quality of cereals and pulses on inclusion of green leafy vegetables has been demonstrated by Talwalker and Patel (1970a), Talwalker and Patel (1970b), Adrian and Peyrot (1971) and Naik et al (1978).

Devadas et al (1971) determined the effects of incorporation of green leafy vegetables into the school lunch programme on the nutritional status of the children. The authors observed that the supplementation with 25g of drumstick (Moringa oleifera) or amaranth (Amaranthus gangeticus) leaves for six months improved the nutritional status of children in terms of growth and hemoglobin status. Similar results have earlier been reported by Anandam et al (1965) in a similar type of study.

In a number of studies beneficial effects of the contribution of green leafy vegetables to calcium, iron and beta carotene intakes have been illustrated. Rajalakshmi et al (1973) had demonstrated that the calcium content of fenugreek leaves was well utilized by preschool children as those fed dhokla with fenugreek leaves in comparison to those fed only dhokla were superior with regards to skeletal status as judged by increments in bone age and cortical thickness of the second metacarpal bone and femur.

Pahwa and Kansal (1980) studied the utilization of calcium from leafy vegetables, spinach (Spinacea oleracea), fenugreek, bengal gram, mustard (Brassica campestris var. sarson) and radish (Raphanus sativus), in rats. Diets contained 30% skim milk powder or 8% green leafy vegetable plus 12% casein. The experiment was conducted for 7 days, preceded by an adjustment period of 3 days. It was observed that the absorption of calcium was quite satisfactory from all green leafy vegetables except spinach. The retention of calcium was higher from fenugreek (71.2%) and bengal gram leaves (74.0%), moderate from mustard (41.2%) and radish leaves (47.2%) and poor from spinach (21.8%). The retention of calcium from skim milk powder was 84.6%.

The green leafy vegetables can provide a considerable part of an adult's daily requirement for iron, hence the physiological availability of the iron of ten green leafy vegetables was determined using the method of hemoglobin regeneration in anemic rats by Oyejola and Bassir (1973-75). The relative biological availability of the iron of the vegetables ranged from 25 to 90% while that of ferrous sulphate was assumed to be 100% available.

Later, Ifon and Bassir (1978) had reported that iron from green leafy vegetables was well absorbed by rats. The efficiency of iron utilization in 8 out of 10 green leafy vegetables used ranged from 19 to 36% while that of ferrous sulphate was 43%. Two green leafy vegetables had shown poor utilization of their iron contents (8 to 11%).

Devadas and coworkers (1973a) have also demonstrated that the availability of iron from amaranth was higher than from iron tonic and iron salt. All supplements provided 13 mg of iron to the diet of the children. The percent increase in hemoglobin values over initial values was higher in children whose diet was supplemented with amaranth (21%) than those received iron tonic (18%) and iron salt (16%) supplementations. A similar picture was observed in the percent increase of packed cell volume in children. In another study, Devadas et al (1973b) showed that amaranth supplementation to the home diet with and without school lunch, significantly improved the hemoglobin levels of the children over an experimental period of 7 months. However, amaranth cooked in iron utensil had significantly improved the hemoglobin values of children over those who received amaranth cooked in aluminium utensil.

Krishnamurthy et al (1976) evaluated the utilization of beta carotene from amaranth in 15 preschool children in a longitudinal study. The study was conducted for a period of 4 months divided into 4 phases of one month each. In the first phase of the study, balwadi supplement was given to the children along with the home diet. In the next 3 phases, 1200 mcg of beta carotene with the supplement was provided to the children. In the second phase beta carotene was supplied from 40 g of amaranth, in the third phase, from 8 g of leaf protein and in the fourth phase from one millilitre of beta carotene standard solution. During the last 3 days of each phase, feces was collected and analysed. The utilization of beta carotene was calculated by determining the difference between the intake and excretion. The absorption of beta carotene was 61.4% when the balwadi diet was supplemented with 40 g of amaranth as against 85.4% when the diet was supplemented with one millilitre of standard beta carotene solution. The value for absorption of beta carotene was 76.7% when the diet was supplemented with 8 g of leaf protein. Since the utilization of beta carotene from amaranth was 72% of that of the standard beta carotene solution, the authors opined that amaranth leaves may be used to enhance the beta carotene content of the diets.

Devadas et al (1980) determined the availability of beta carotene from amaranth in preschool children, in a cross-sectional study. Forty children were divided into 3 groups, all the groups received balwadi diet for one month. Then group one continued to receive the same diet and groups 2 and 3 received 30 g of amaranth providing 1200 mcg of beta carotene or 300 mcg of retinol. It was observed that the absorption of beta carotene was 73% from amaranth leaves. Serum vitamin A levels significantly improved from 13.9 mcg/dl (unsupplemented value) to 28.7 mcg/dl when the diet was supplemented with amaranth. However in the group given retinol as the supplement, a higher increase was recorded (from 13.9 to 22.7 mcg/dl). Even the blood hemoglobin level showed a marked increase (2.2 g/dl) in the group fed on amaranth supplemented diet as compared to that (1.9 g/dl) of group on retinol supplemented diet. Hence amaranth has been recommended to increase the beta carotene and iron contents of the diets.

Jayarajan et al (1980) determined the absorption of beta carotene from spinach in children. Seventy children between 2 and 6 years of age were divided into 3 groups. On clinical examination 12 of the 70 children had clinical signs of vitamin A deficiency such as conjunctival xerosis and bitot spots. All children received a daily supplement of 40 g of spinach which provided 1200 mcg beta carotene with 0, 5 or 10 g of groundnut oil. The supplements were given along with 50 g of cooked rice for a period of 4 weeks. Initially, mean levels of serum vitamin A were similar in the 3 groups of children (20.4 to 20.7 mcg/dl). Four weeks after supplementation there was a significant rise in the mean vitamin A level in all the 3 groups. The rise in vitamin A concentration was more marked in children whose initial serum vitamin A levels were below 20 mcg/dl than those who had higher levels. The mean increase in serum vitamin A was higher in the groups who received additional fat in the diet, although the serum vitamin A levels did not vary whether the supplement contained 5 or 10 g of oil.

Devadas (1978) determined the availability of beta carotene from fresh and dried fenugreek and drumstick leaves. The home diet of preschoolers was supplemented for a period of 2 and a half months with fresh or dried fenugreek and drumstick leaves or with a beta carotene tablet to provide 1200 mcg per child per day. The rise in serum vitamin A levels over the initial values was comparable between the children who received standard beta carotene (60%) and the fresh green leafy vegetable (63 to 66%) but those who received dried leafy vegetable exhibited a smaller increase in serum vitamin A levels (55 Vs 60%). The authors concluded that the response to green leafy vegetable supplementation in terms of serum vitamin A level was as good as the standard beta carotene supplementation.

Rajalakshmi et al (1975) determined comparative availability of beta carotene from different leafy vegetables to that of vitamin A acetate in vitamin A depleted rats. Leaves of amaranth (5 g), colocasia (2 g), drumstick (5 g), fenugreek (8 g) and spinach (6 g) were provided in addition to the basal diet to give 156 to 216 mcg of carotenes or vitamin A/100 g diet so that the total carotene intake ranged from 480 to 700 mcg. One group of rats received vitamin A acetate to provide 150 mcg of vitamin A per 100 g diet so that the total vitamin A intake was 480 mcg. Serum vitamin A levels as percent of total carotene/ vitamin A intake of rats fed leafy vegetables (2.4 to 5.1%) were comparable to that of those given vitamin A acetate (3.6%). But the liver stores considered as percent of carotene or vitamin A intakes, varied from 16 to 17% in the case of amaranth and colocasia to 50% for spinach and 63% for vitamin A. These results indicated the high physiological potency of beta carotene in leafy vegetables.

Sensory evaluation - methods being used

Govindarajan and Rajalakshmi (1977) suggested that if any food has to be accepted it should give the consumer, satisfaction and pleasure. The acceptance of a product by a consumer depends on qualities he can readily perceive and experience, such as, the colour and appearance, taste, texture and aroma of foods. These are the sensory responses of the consumer to the food. The measurement of these sensory responses is considered to estimate the overall quality of a food material. However, since each variation of a product or a formulation could be tested at the consumer level, it became necessary to standardize conditions of testing a formulation with a selected and trained panel under optimal conditions (Cauf 1970). The assumption herein is that if by sensory testing a product is approved by such a critical panel, the consumer who is generally less critical or sees it as a whole and not analytically, will approve the product.

Threshold test : Threshold tests to assess the ability of individuals to detect different tastes, odour and to feel the presence of specific factors e.g., bite principle or astringency are used to select and train panel members for evaluating the quality of products (Swaminathan 1979). According to Amerine et al (1965) there are two different thresholds, detection and recognition.

The detection threshold has been described as the magnitude of a stimulus at which a transition occurs from no sensation to sensation while recognition threshold is the minimum concentration at which a substance is correctly identified (Amerine et al 1965).

Hardy et al (1981) evaluated detection and recognition thresholds in individuals with the help of various concentrations of test solutions; sodium chloride, sucrose, citric acid and quinine sulfate. The solutions were tested by forced choice triangle method. Three drops were consequently placed on the tongue in predetermined random order of which 2 drops were of double distilled water and one was of the test solution. The subjects were introduced to the taste of the double distilled water before the testing began. Each subject was asked to determine which of the three drops was different and to designate its taste. Eight different concentrations of each stimulus were presented in increasing order. The subjects were allowed to sample the solutions more than once if they were not sure of their responses. When the subjects either had correctly detected and identified a particular stimulus consequtively or had tested all eight concentrations, they were allowed to begin the next set of stimuli. A correct response followed by an incorrect response was assumed to be a guess. The concentration of the first response of the three correct responses was considered as the threshold value. The threshold values were determined as that point where 50% of the individuals detected or recognised a particular taste.

Whether nationality would influence taste thresholds was investigated by Druz and Baldwin (1982). Six acqueous solutions of sucrose, citric acid, caffeine, and sodium chloride were prepared. Panelists were presented 2 samples at a time, of which one was distilled water and the other was the test solution. The order of serving pairs and samples within pairs was randomized. Additionally, the order of presentation for each primary taste series was randomised for each panelist. Panelists were asked to identify the samples with the most intense taste within each pair. All 6 pairs of samples from each of the 4 primary taste series were evaluated at each of the 4 panel sessions. The results indicated that the taste thresholds for the acqueous solutions did not differ among panels from Nigeria, Korea and the United States.

Johnson and Clydesdale (1982) provided panelists with different concentrations of sucrose solutions in ascending or descending order. Each judge was presented with one of the lowest sucrose concentrations and instructed to respond with a 'yes' if sweetness was detected or 'no' if it was not. After each negative response, another sample with a higher sucrose concentration was presented for evaluation until the judge responded with two consequtive 'yes' replies. This was the ascending series of solutions. A descending series was then presented beginning with a sample two concentrations higher than the last 'no' response. Two consequtive negative responses following a 'yes' marked the end of the descending series. The stimulus threshold for each series was calculated as the sucrose concentration, midway between the sample where the verbal response changed from 'yes' to 'no' or 'no' to 'yes'. The panelists had to undergo 10 evaluations of both the ascending and descending series (5 each). Stimulus threshold was taken as the minimum sucrose concentration at which a sweet taste can be detected. The stimulus threshold of each individual was calculated for each ascending and descending series by an arithmatic average of these 10 values to give the subjects overall stimulus threshold for sweetness.

Triangle test : In this test, three samples, two identical and one different are presented to the panel for identification of the odd sample. The triangle test is used for product development and improvement and quality control, for measuring the sensory properties of foods, for determination of difference and direction among samples and for training and selecting judges (Amerine et al 1965, Swaminathan 1979, Sosulski and Fleming 1979, Fritzers 1981, Gatchalian 1981, Hayashi et al 1981).

Sosulski and Fleming (1979) used triangle test to establish the reliability and competence of the groups. The panelists were presented with breads prepared from composite flours and were asked to identify the odd sample and to indicate the degree of difference between the duplicate and odd samples. The panel members who could not discern the samples were eliminated from further tests. Hayashi et al (1981) had used triangle test for taste panel assessments. All the taste panel assessments, i.e., omission and addition tests were run by the triangle difference test in which a set of test solutions (one odd and 2 duplicate samples) were presented at room temperature, to each panel member who was instructed to identify the odd sample. The number of correct answers was statistically processed using the table of criterion for the triangle difference test.

Scoring test : In the composite scoring test, the scores are given for various quality characteristics of the product such as colour, consistency, flavour and absence of defects and the total score is taken for overall acceptability of the product (Swaminathan 1979).

Garcha et al (1971) had evaluated sweet and salty biscuits containing 5% sarson leaf protein for appearance, flavour, texture, taste and acceptability by scoring test. Each characteristic was scored out of 100 and mean score for each characteristic was calculated for comparison between sweet and salty biscuits.

Sarode et al (1983) evaluated biscuits by multiple scoring method. Each characteristic such as appearance, texture, flavour, taste and acceptability was scored on a 10 point scale. Average total score out of 50 was recorded for acceptability comparisons.

Scoring system has been used by Vaidehi et al (1986) for the sensory evaluation of biscuits made of ragi, malted and unmalted, flour and oil seed flour blends. The biscuits were scored for appearance, texture, aroma, flavour and overall eating quality on a scoring system ranging from 1 (very poor) to 5 (very good).

Juneja et al (1980) determined the acceptability of chapaties by scoring test. Code numbers were given to different types of chapaties and each type was evaluated thrice. Each day the judges were served with 2 different types of chapaties and they were asked to score the chapaties for colour, taste, doneness, chewing and overall acceptability by using a score card bearing scores from 1 to 7 for strongly favourable to strongly unfavourable. The mean scores of the sensory evaluation for each characteristic were then calculated.

Hedonic scale : Hedonics relates to the psychology of pleasurable and unpleasant states of consciousness. In hedonic scaling affective responses, i.e., psychological states of likes and dislikes are measured on a rating scale (Amerine et al 1965).

The ratings for each sample are given numerical values ranging from like extremely (9) to dislike extremely (1) for ease in statistical analysis. The hedonic scale can be used in research laboratories to ascertain the acceptability of new products (Swaminathan 1979).

Hedonic scale has been used by Taur et al (1984b) to organoleptically evaluate 5 varieties of chips for the quality attributes such as colour, flavour, taste, texture and overall acceptability on a 5 point scale. The scores given by the judges were statistically analysed for significant differences between the means of each attribute. Druz and Baldwin (1982) had evaluated tomato juice and apple sauce on a 5 point hedonic scale in which the phrase "like very much" was assigned a value of 5 and "dislike very much" was given a value of 1. Meimban et al (1982) and Gandhi et al (1983) used a 9 point hedonic scale to evaluate the acceptability of food products. Ratings ranged from like extremely or very good to dislike extremely or extremely poor, the higher scores indicating better qualities.

Acceptability trials

Acceptability trials are conducted on the potential consumers to determine the acceptability or preference of products. In a number of trials, the acceptability of a product has been determined by its intake at one sitting.

Inamdar (1980) and later Tajuddin (1981) had conducted acceptability trials on malted and roasted ready to eat (RTE) mixes. The malted RTE mix was considered more acceptable because its mean consumption was significantly higher than that of the roasted RTE mix.

In contrast, Master (1981) had prepared malted and roasted RTE mixes from 80 g of wheat, bengal gram and groundnut (4:1:1) mix and 20 g of jaggery and compared their acceptability on children (1 to 3 years). The mean intake of malted RTE mix was 101 g while that of the roasted RTE mix was 109 g indicating better acceptability of the roasted RTE mix as compared to that of the malted RTE mix.

Nayak (1983) determined the acceptability of biscuits prepared from mixes based on malted and roasted wheat and bengal gram (4:1). The formulation consisted of 40 g mix, 40 g jaggery and 20 g hydrogenated fat. The weight of one biscuit was approximately 8 g. Feeding trials were done for 2 days with an interval of a day in between. The mean intake of biscuits prepared from malted mix was 66 g in comparison to 61 g of biscuits prepared from roasted mix. The results revealed that both the types of biscuits were equally acceptable and that malting of wheat did not lead to any improvement in the intake of biscuits.

Pasricha et al (1973) conducted acceptability trials on preschoolers on pressed rice ladoo, barfi, maize puttu, jowar upma, wheat germ ladoo, jowar and bajra kitchri and biscuits. Each product was fed to the children for one day. The criteria for acceptance were : (a) 75% of the children under study should eat the product and (b) each child should be able to consume the portion served at one sitting. All the recipes were found to be accepted by all children, biscuits were liked the most.

In nutshell, biscuits, cookies and crackers have been found to be very popular snack items (Pasricha et al 1973, Menon et al 1980). They have relatively long shelf life and good eating qualities. The nutritive composition of biscuits can be improved by (a) the use of cereal-pulse combination, (b) use of malted grains and (c) addition of green leafy vegetables.

For sensory evaluation of products, scoring tests (Garcha et al 1971, Juneja et al 1980, Sarode et al 1983, Vaidehi et al 1986) and hedonic scales (Meimban et al 1982, Gandhi et al 1983, Taur et al 1984) have been used.

Acceptability of products has been determined by many investigators (Rau et al 1975, Inamdar 1980, Tajuddin 1981, Master 1981, Nayak 1983) by the amount of intake at a 'sitting'.

This study aimed at the preparation of a snack, viz., biscuits using mixes prepared from malted and raw wheat and bengal gram with or without green leafy vegetables with the objectives of (a) to prepare biscuits from mixes containing jaggery as the sweetening agent and fenugreek or colocasia leaf powder as mineral and vitamin enhancers and to pretest the biscuits on children and their mothers in an attempt to standardize the recipe, (b) to carry out sensory evaluation of the biscuits in the laboratory, and (c) to conduct acceptability trials of the biscuits on children.

Materials and methods

Preparation of biscuits from wheat and bengal gram mix containing jaggery as the sweetening agent

Ingredients used in biscuit preparation

Mix prepared from malted wheat and bengal gram : The possibility of using a cereal-pulse combination in biscuit making has been discussed by Warren et al (1983) and Lorenz (1983). Wheat (amber coloured grains) and bengal gram (desi, brown coloured grains) commonly used cereal and pulse in Gujarat, were malted to enhance their nutritive quality (Babu 1976, Dalby and Tsai 1976, Ganesh Kumar and Venkataraman 1975, Jaya and Venkataraman 1980, Wu 1982, Krishnamurthy and Venkataraman 1983), and were used in biscuit preparation. The essential amino acid pattern of wheat and bengal gram (4:1, by weight) mix protein is given in Table 13. The table also shows that the chemical score of the mix (71%) was higher than the chemical score of wheat (50%) and was close to that of bengal gram (73%).

Green leafy powder : The choice of green leafy vegetable was based on the following criteria, (a) it should be commonly used in Gujarat, (b) it should be fairly cheap when in season, (c) it should be specifically rich in calcium, iron and beta carotene, (d) it should be preferably low in oxalic acid and (e) it could be dried and stored for further use. Fenugreek and colocasia leaves satisfied these criteria. Since fenugreek leaves are commercially available in dry form and are commonly used in

Table 13. Essential amino acid pattern and amino acid score of wheat and bengal gram (4:1) mix

	Lysine	Tryptophan	Phenylalanine Tyrosine	Methionine + Cystine	Threonine (g/gN)	Leucine	Isoleucine	Valine	Chemical score
Amino acid scores of wheat and bengal gram (4:1) mix	0.71[a]	1.08	1.27	0.96	0.76[b]	1.04	0.99	0.93[c]	71
Amino acid scores of wheat	0.50[a]	1.17	1.21	1.04	0.72[b]	0.93	0.88[c]	0.90	50
Amino acid scores of bengal gram	1.29	0.83[b]	1.42	0.73[a]	0.88[c]	1.32	1.28	1.00	73
FAO Reference Pattern (1973)[d]	340	60	380	220	250	440	250	310	

Essential amino acid pattern taken from Gopalan et al (1985)

[a]First limiting amino acid

[b]Second limiting amino acid

[c]Third limiting amino acid

[d]FAO/WHO (1973)

Gujarat not only as a vegetable but are also incorporated into unleavened breads called 'teplas', fenugreek leaves were the first choice.

Sweetening agent : Sugar or jaggery (crude brown sugar) was used as the sweetening agent. Later, jaggery was preferred over sugar in biscuit preparation because it imparts its own colour and flavour to the biscuits, helps in masking the flavour of green leafy vegetable if incorporated into biscuits and is relatively lower in cost compared to sugar. In addition, it is nutritionally superior to sugar with regards to calcium and iron contents.

Shortening : Vanaspati, hydrogenated vegetable oil, was used as a shortening agent in biscuit preparation.

Malting procedure

As described in Chapter 3, wheat and bengal gram were cleaned, and weighed separately in the ratio of 4:1. The grains were soaked in thrice their volume of water for 12 h. The water was then completely drained out. The grains were tied loosely in a moist muslin cloth and kept for germination for 48 h at 28°C (17 to 38°C). The grains were turned in and turned out every 12 h to facilitate aeration.

Germination was terminated by drying the grains on a wire mesh rack for 2 h. After the evaporation of superficial moisture, the grains were dried to the core in an oven at 70±5°C for 9 to 11 h. The dried grains were milled in a mini flour mill in the laboratory. Whole flour (100% extraction) was used in the preparation of biscuits.

Drying of leaves

Fenugreek leaves obtained from the local market were washed and their stems were removed. The leaves were formerly air dried for 2 h and later oven dried at 60°C. The dried leaves were powdered and used in the preparation of biscuits.

Colocasia leaves obtained from the local market were washed and wiped dry. The mid ribs and the prominent side ribs were removed with a stainless steel knife. The leaves were air dried for 2 h and then oven dried at 60°C. The dried leaves were powdered and used in the preparation of biscuits.

The nutritive value of fenugreek and colocasia leaf powders displayed below reveals that the leaves are rich in calcium, iron

Nutritive value[a] (per 100g) of fenugreek and colocasia leaf powders

	Calcium (mg)	Iron (mg)	Carotene (mcg)	Fibre (g)	Protein (g)	Oxalic acid (mg)
Fenugreek leaf powder	2,577	107.7	15,269	7.2	28.7	85
Colocasia leaf powder[b]	1,579	109.0	52,612	11.4	24.8	225[c]

[a]Gopalan et al (1985)
[b]Mean values of green and black varieties of colocasia leaves
[c]Value of green variety of colocasia leaves

and beta carotene with fairly low oxalic acid contents. Both the leaves are commonly used in Gujarat and can be dried, powdered and stored for future use. Colocasia leaves are of two varieties, black and green (Gopalan et al 1985). In the open market the leaves are not available as of one pure variety hence average values for calcium, iron, beta carotene, fibre and protein contents of both varieties were used for calculation purposes.

Preparation of biscuits

Biscuits using malted mix were prepared with or without fenugreek leaf powder. Many recipes for biscuits have been formulated containing green leafy vegetables (Pushpamma and Geervani 1981). In the present study the recipe of NIN (1978) for biscuit preparation was used with modification, that instead of 20% (dry weight basis) jaggery 15% of sugar was used. The ingredients used in biscuits preparation are displayed below:

Recipe	Biscuits			
	Sweet		Salty	
	+F	-F	+F	-F
Ingredients (g)				
Malted mix	78	80	93	95
Vanaspati	5	5	5	5
Ground sugar	15	15	-	-
Salt	-	-	to taste	to taste
Fenugreek leaf powder	2	-	2	-
Baking powder	0.25	0.25	0.25	0.25

F = fenugreek leaf powder

Procedure : The dry ingredients (flour, leaf powder and baking powder) were sifted together. The shortening was creamed with ground sugar. The dry ingredients were added to the creamed mixture and were kneaded using optimum amount of water to prepare the dough. The dough was rolled out and cut into circles. The biscuits were baked in an oven at 200°C for 10 min.

Preliminary organoleptic evaluation of the biscuits

The fenugreek leaf powder incorporated into the biscuits at 2% level provided 52 mg of calcium, 2.2 mg of iron and 305 mcg of beta carotene. The biscuits were subjected to organoleptic evaluation (a) to modify the recipe, if necessary, in order to obtain an organoleptically acceptable biscuit, (b) to find out whether the children (3+ years) will accept biscuits containing a green leafy vegetable, (c) to arrive at the acceptable level of green leafy vegetable to be included in the biscuit, (d) to explore whether their mothers would like to purchase the biscuits if made available in the market.

In order to investigate if the recipe needed any modifications, the staff members and the Ph.D. students of the Department of Foods and Nutrition, Faculty of Home Science, M.S. University, Baroda, were requested to evaluate the biscuits for detectable bitterness, after taste, flavour and crispness/hardness. The card given to the evaluators was as shown below:

Name : Date :

Characteristic	Responses Sample 1	Sample 2
Detectable bitterness		
After taste		
Flavour		
Crispness/hardness		
Any other		

The organoleptic evaluation of biscuits with and without fenugreek leaf powder revealed that the sweet biscuits were preferred to the salty ones. Similar observation had been made by Garcha et al (1971) that organoleptically, the panelists preferred sweet biscuits over salty biscuits containing 5% sarson leaf protein. In the present study, all the evaluators stated that biscuits with fenugreek leaf powder had unacceptable bitter taste, after taste and flavour. Some of them found the biscuits less sweet and hard.

Therefore, the recipe was modified by reducing (a) the fenugreek leaf powder from 2 to 1% and by increasing the (b) shortening from 5 to 10%, (c) sugar from 15 to 30% and (d) baking powder from 0.25 to 0.5 g. As a corollary, in one lot of biscuits, the fenugreek leaf powder was boiled and then incorporated in an attempt to destroy the bitter component of the fenugreek leaves. Also, 2 teaspoons of lime juice were added in the preparation of salty biscuits containing 1% of fenugreek leaf powder.

The biscuits were organoleptically evaluated as described earlier. The results revealed that (a) the biscuits prepared from 1% fenugreek leaf powder still had unacceptable bitter taste and after taste, (b) the biscuits remained unacceptably hard, (c) the biscuits prepared from boiled leaf powder were better accepted than those containing dried fenugreek leaf powder and (d) the addition of lime juice made no appreciable difference in the taste of salty biscuits. As the biscuits had an unacceptable taste it was therefore thought that jaggery be used instead of sugar to mask the unacceptable taste of fenugreek leaf powder, and the fat content be further increased.

In another attempt, sweet biscuits were prepared using 40% jaggery, 15% shortening and 1% fenugreek leaf powder and sweet-salty biscuits were prepared using 30% jaggery, 15% shortening, 1% fenugreek leaf powder and salt to taste. These biscuits were organoleptically evaluated by the same evaluators using the criteria described earlier. Sweet biscuits were preferred over sweet-salty ones. The bitter taste of the fenugreek leaf powder was perceptible even when included at 1% level. At 1% level, fenugreek leaf powder provided 26 mg of calcium, 1.1 mg of iron and 153 mcg of carotene. Considering that the inclusion of fenugreek leaf powder into the biscuits at such a low level would not provide any nutritional benefits, colocasia leaves were used instead.

The colocasia leaf powder was incorporated into the recipe at 1 and 2% levels to determine whether the biscuits with colocasia leaf powder would at all be acceptable. The biscuits prepared using the same recipe and subjected to organoleptic evaluation as previously described were found to be equally acceptable at both the levels of colocasia leaf powder. But in order to further increase the caloric value and improve the texture of the biscuits, the shortening was increased from 15 to 20%.

Finally, biscuits containing 39 g of mix, 1 g of colocasia leaf powder, 40 g of jaggery and 20 g of shortening were prepared. The biscuits were found to be acceptable by the panel members. These biscuits were then pretested on children and their mothers.

Pretesting the biscuits on children and their mothers

In order to find out whether children (3+ years) will accept the biscuits containing a green leafy vegetable and whether their mothers would like to purchase the biscuits if made available in the market, the biscuits were pretested on children and their mothers.

A preliminary trial to know whether biscuits containing green leafy vegetable would at all be acceptable was conducted on balwadi children. The biscuits containing 1% colocasia leaf powder were prepared in the laboratory, and were pretested for acceptability on 4 to 6 year old balwadi children of the Department of Child Development, Faculty of Home Science, M.S. University of Baroda, Baroda.

Each child received 2 biscuits and if the child ate both the biscuits and asked for more, the biscuits were considered to be acceptable. All the children (15) consumed 2 biscuits each and demanded more which indicated that the biscuits with 1% colocasia leaf powder were acceptable.

The Windsor Biscuit Factory, Baroda, was then requested to prepare biscuits containing colocasia leaf powder based on the recipe that had been standardized in the laboratory, to find out the feasibility of the production of these biscuits on a commercial basis. The biscuits with 39 g of mix, 1 g of colocasia leaf powder, 40 g of jaggery and 20 g of vanaspati were prepared.

The acceptability of the biscuits was evaluated on 10, three to five year old children of another balwadi. Each child was given 5 biscuits in the beginning and was asked to feel free to demand more. The intake of biscuits ranged from 4 to 7 at one sitting. All the children, except one, liked the biscuits.

The mothers of these children were requested to evaluate the biscuits for appearance, colour, mouthfeel, crunchiness, taste and after taste. The consumption pattern of biscuits in their families, and whether they would buy these biscuits if made available in the market was found out with the help of an interview schedule. One biscuit was given to each mother for testing. The results are presented in Table 14.

Table 14. Responses of mothers to the interview schedule

Sr. No.	Characteristics/Questions	No. of acceptable/ Yes responses
	Appearance	8
	Colour	3
	Mouthfeel	No response
	Crunchiness	No response
	Taste	10
	After taste	10
1.	Did you like the biscuits?	10
2.	Do you think your child will like these biscuits?	10
3.	Do you buy biscuits from the market?	9
4.	Will you buy these biscuits if these are made available in the market at the	
	a) same cost	8
	b) higher cost	2
5.	Will you prepare the biscuits at home if you are taught how to make them?	0
6.	Do you use green leafy vegetables in routine family meals?	8
	a) How often	
	(i) every day	
	(ii) twice a week	1
	(iii) once a week	6
	(iv) any other (sometimes)	1

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Table 14 contd..

Sr. No.	Characteristics/Questions	No. of acceptable/ Yes responses
	b) Why do you use them	
	(i) easily available	No response
	(ii) cheap	No response
	(iii) rich in minerals and vitamins	No response
	(iv) any other	Taste, variety, do not think before buying
7.	Did you realise that green leafy vegetable was incorporated into the biscuits?	2
8.	Do you think these biscuits are nutritionally superior to those without a green leafy vegetable?	No response

All the ten mothers found these biscuits acceptable in terms of taste and after taste characteristics. However the appearance was acceptable to only 80% of them and the colour to only 30%. None of the mothers could respond to characteristics such as mouthful and crunchiness probably these two characteristics were not well understood by the mothers.

All the mothers liked the biscuits, and were of the opinion that their children would also like these biscuits. Ninety percent of the mothers buy biscuits from the market. Eighty percent of the mothers said that they would buy these biscuits if made available at the price of the commercial biscuits although 20%

of them even agreed to buy these biscuits if available at a relatively higher cost. None of the mothers however expressed willingness to prepare biscuits at home due to lack of time. Eighty percent mothers stated that they used green leafy vegetables in the routine family meals, of those who used green leafy vegetables, 75% used once in a week, 12% twice in a week and 12%, sometimes. Eighty percent of the mothers could not make out that green leafy vegetable was incorporated into the biscuits. None of the mothers were found to be aware of the nutritional importance of the green leafy vegetable.

After having pretested the biscuits containing colocasia leaf powder on children and their mothers, an attempt was made to increase the level of colocasia leaf powder for nutritional benefits. Thus another study was planned to determine the optimum level of colocasia leaf powder to be incorporated into the biscuits. The biscuits were prepared containing 2 to 10% colocasia leaf powder and were subjected to sensory evaluation.

Sensory evaluation of the biscuits in the laboratory

The junior M.Sc. students of the Faculty of Home Science, Baroda, were requested to undergo the training tests of sensory evaluation. The panel members were selected on the basis of threshold test, the selected members were trained through the triangle test to detect differences among the biscuits. The trained panel evaluated the biscuits by composite scoring test and hedonic scale.

Threshold test : The identification threshold test was used to select the panel members. For threshold tests, sweet and bitter solutions were prepared at the concentrations given by Swaminathan (1979). Nine concentrations (Table 15) of sucrose solutions used in the present study ranged from 0.0002 to 0.0512 M (0.007 to 1.753%) and six concentrations of caffeine solutions from 0.00005 to 0.0008 M (0.001 to 0.016%). Various concentrations of sucrose and caffeine/quinine sulfate solutions have been used for threshold tests. Hardy et al (1981) had used 8 concentrations of sucrose ranging from 0.20 to 1.60% and of quinine sulfate ranging from 0.0003 to 0.0024%. While Druz and Baldwin (1982) had used six concentrations of sucrose and caffeine ranging from 0.009375 to 0.3% and 0.00025 to 0.008%, respectively. Johnson and Clydesdale (1982) used 7 sucrose concentrations ranging from 0.001 to 0.029 M. The concentrations of sucrose and caffeine solutions used in the present study (Table 15) were comparable to those used by other investigators (Hardy et al 1981, Druz and Baldwin 1982, Johnson and Clydesdale 1982).

Solutions of sucrose and caffeine were prepared in distilled water 24 h prior to testing. The solutions were transferred into numbered bowls and were arranged in the increasing order of concentrations of the test solutions. Each panel member was provided with a score card (Appendix 1) and was asked to identify the taste and give an intensity score to the solutions, as per the intensity scale shown on the score card. The intensity scale ranged from 0 to 5 (0 = none or the taste of pure water, ? = different from water, but taste quality not identifiable,

Table 15. Concentrations of sucrose and caffeine solutions used for threshold test

Solution No.	Sweet (sucrose)		Bitter (caffeine)	
	Molarity	%	Molarity	%
1	0.0002	0.007	0.00005	0.001
2	0.0004	0.014	0.0001	0.002
3	0.0008	0.027	0.0002	0.004
4	0.0016	0.055	0.0004	0.008
5	0.0032	0.110	0.0006	0.012
6	0.0064	0.219	0.0008	0.016
7	0.0128	0.438		
8	0.0256	0.877		
9	0.0512	1.753		

X = threshold very weak or taste identifiable, 1 = weak taste, 2 = mild taste, 3 = strong taste, 4 = very strong taste and 5 = extremely strong). The subjects were allowed to sample the solutions more than once if they were not sure of their scores. Rinsing of mouth with water was recommended between samples. When the subjects had finished scoring one set of stimuli they were allowed to begin the next.

The identification threshold test was conducted for 6 days. An arithmetic average of these 6 values was calculated to give the subjects overall identification threshold for sweetness and bitterness. A group identification threshold was calculated from the averages of the individual overall identification thresholds. The variability of responses for each member within the calculated group threshold was determined from the standard error of the mean. Percent correct response for each trial per individual was calculated. Average percent correct response for all the six trials for one individual was calculated to give an overall percent correct response for sweetness and bitterness. A group percent correct response from the averages of all the panel members was then calculated. Out of the 28 subjects who had undergone the threshold tests, 17 subjects were selected. The selection of subjects was based on their ability to identify the taste stimuli and their consistency in identifying the taste at the same concentration at least twice in six trials in both the taste stimuli. The subjects who had threshold within the concentration provided for sucrose (less than 1.753%) and caffeine (less than 0.016%) and who were considered consistent were selected for the triangle test. Seventeen subjects were selected for the triangle test.

The group identifiable threshold values were found to be 0.261 and 0.005% for sucrose and caffeine solutions, respectively (Table 16). The threshold value for sucrose solution was

Table 16. Identification taste threshold values expressed as percent concentration and percent correct responses of 17 panel members

	Taste	
	Sweet	Bitter
Group identification threshold (%)	0.261±0.036	0.005±0.001
Group percent correct responses	75.3±3.926	80.8±2.423

comparable to that observed by Johnson and Clydesdale (1982) and Druz and Baldwin (1982) but was lower than that observed by Hardy et al (1981). The latter authors had reported a recognition threshold of 0.830% for sucrose solution. Likewise, the threshold value of 0.005% for caffeine was lower than that reported by Druz and Baldwin (1982).

Triangle test : The triangle test was used to train the panel members on product differentiation and to determine if significant differences existed between the samples presented to the panel members (Larmond 1982). A total of five evaluations were conducted. In four tests, biscuits containing colocasia leaf powder incorporated at 2 levels were evaluated. The amount of colocasia leaf powder varied from 2 to 10%. In one of the tests biscuits containing 10% colocasia leaf powder prepared from either malted or raw mix were evaluated. The comparisons were made between biscuits containing 2 or 3%, 3 or 5%, and 5 or 10% colocasia leaf powder and also between biscuits prepared from malted or raw mix containing 10% colocasia leaf powder. Three biscuits, two of identical and one of different type were presented simultaneously to the panel members. The panel members were allowed to taste the samples more than once if they were doubtful of their judgements and to rinse their mouths before tasting each sample. The panel members were presented with a card (Appendix 2) and were asked to mark the odd sample. The test was conducted in a room and panel members were allowed in the room one at a time. The biscuits were presented under coloured light to mask the differences produced in the colour of the biscuit due to different concentrations of greens used in biscuit preparation. In test one, biscuits containing 2 or 3% colocasia leaf powder were presented to the panel members. The number of correct answers was statistically processed using the table of criterion for the triangle difference test (Larmond 1982). It was observed that only 3 out of 8 panel members could identify the odd sample indicating that no significant differences existed between the biscuits containing 2 or 3% colocasia leaf powder (Table 17).

Table 17. Difference analysis[a] of responses for the triangle test

Test No.	Biscuits	No. of tasters	No. of correct answers	Statistical significance
1.	2% or 3% colocasia biscuits	8	3	NS
2.	3% or 5% colocasia biscuits	15	2	NS
3.	5% or 10% colocasia biscuits	8	7	S**
4.	5% or 10% colocasia biscuits	14	12	S***
5.	10% colocasia malted or raw mix biscuits	16	11	S**

[a]Larmond (1982)

NS = Non Significant
** = Significant at 1% level of significance
*** = Significant at 0.1% level of significance

Similarly in test 2, when biscuits containing 3 or 5% colocasia leaf powder were tested by the panel members (Table 17) no significant difference was found between the two samples. In tests 3 and 4, where biscuits containing 5 or 10% colocasia leaf powder were evaluated the results indicated that there was a significant difference between the two types of biscuits indicating that biscuits containing 5% colocasia leaf powder could be differentiated from those containing 10% colocasia leaf powder (Table 17). In test 5, where the level of green leafy vegetable was kept constant at 10% and mixes made from malted or raw wheat and bengal gram were used, again a significant difference between the biscuits was observed.

Composite scoring test and hedonic scale : The purpose of these tests was to determine the level at which the colocasia leaf powder in the biscuits would be best tolerated by the panel members.

In 3 tests, biscuits containing colocasia leaf powder at 5 and 10% levels were evaluated. The panel members were provided with both types of biscuits simultaneously in one test. In the composite scoring test, the biscuits were evaluated for appearance, texture, after taste, leafy flavour and acridity (irritation in the throat). Scores were alloted to various characteristics and the total score was 50. Higher scores were given to those characteristics that were expected to have a greater bearing on the sensory properties of the biscuits. A score card was given to the panel members for evaluation of biscuits (Appendix 3). Scoring test has been used by many investigators to test the acceptability of the biscuits (Garcha et al 1971, Meimban et al 1982, Kahn and Penfield 1983, Sarode et al 1983).

For the hedonic scale, a 9 point scale ranging from like extremely (9) to dislike extremely (1) was used. The hedonic scale used in the present study is given in Appendix 4. The scores were statistically analysed by student's 't' test (Snedecor and Cochran 1968) and trend analysis (Edwards 1960).

From the results of the triangle test, it was clear that the subjects could not differentiate between the biscuits containing 2 or 3 and 3 or 5% colocasia leaf powder (Table 17). Considering that the biscuits containing 5% and less than 5% colocasia leaf powder had comparable sensory qualities, in the next set of tests the possibility of incorporating colocasia leaf powder into biscuits at a level higher than 5% was explored in an attempt to meet a 4 to 6 year old child's recommended daily allowances for calcium, iron and carotenes.

In 3 tests, 5 and 10% colocasia-malted mix biscuits were evaluated for appearance, texture, taste, leafy flavour, after taste and acridity. The mean scores of each characteristic of 5 and 10% colocasia leaf powder containing biscuits are presented in Table 18. Although the mean values of total scores of 10% colocasia biscuits were significantly smaller than those of the 5% colocasia biscuit in 2 out of 3 tests, but the scrutiny of the mean scores for various characteristics revealed that except for scores for texture, taste and after taste no significant differences were observed between the mean scores of any of the characteristics of 5 or 10% colocasia leaf powder containing biscuits. The trend analysis of the data revealed that there was no trend in any of the tested characteristics in the 3 days' trial

Table 18. Means and standard errors of the composite scoring test scores

Test No.	Level of colocasia leaf powder in biscuits	Total scores (50)	Appearance (5)	Texture (5)	Taste (15)	Leafy flavour (10)	After taste (10)	Acridity (5)
1.	5%	34.29 ±1.427	3.57 ±0.251	3.36 ±0.248	11.57 ±0.488	6.21 ±0.622	6.93 ±0.355	2.64 ±0.427
	10%	30.64 ±1.265	3.00 ±0.234	2.79 ±0.187	9.93 ±0.518	5.93 ±0.707	6.50 ±0.403	2.50 ±0.359
	't' values	1.914 NS	1.657 NS	1.833 NS	2.307*	0.297 NS	0.801 NS	0.251 NS
2.	5%	34.78 ±1.350	3.31 ±0.175	3.23 ±0.201	11.38 ±0.525	6.69 ±0.624	7.46 ±0.268	2.69 ±0.444
	10%	30.38 ±1.635	2.92 ±0.265	3.08 ±0.288	9.77 ±0.717	6.08 ±0.459	6.23 ±0.342	2.31 ±0.414
	't' values	2.076*	1.226 NS	0.427 NS	1.811 NS	0.787 NS	2.828**	0.626 NS
3.	5%	33.31 ±1.416	3.08 ±0.211	3.62 ±0.180	11.08 ±0.560	6.31 ±0.485	6.77 ±0.521	2.46 ±0.386
	10%	28.77 ±0.885	2.77 ±0.166	2.92 ±0.239	8.92 ±0.383	6.23 ±0.455	5.85 ±0.355	2.08 ±0.309
	't' values	2.719*	1.157 NS	2.349*	3.181**	0.120 NS	1.460 NS	0.768 NS

NS = Non Significant

* = Difference between means significant at 5% level of significance

** = Difference between means significant at 1% level of significance

Figures in parenthesis denote scores alloted to each characteristic for biscuit evaluation (Table 19). However the total scores and scores for texture and taste of the 5% colocasia-malted mix biscuits were significantly higher than those of the 10% colocasia-malted mix biscuits although the scores for appearance, leafy flavour, after taste and acridity of the 5 and 10% colocasia-malted mix biscuits did not differ significantly from each other. The results gave an indication that 5% colocasia-malted mix biscuits were more acceptable than 10% colocasia-malted mix biscuits.

In the 3 tests, biscuits containing 5 and 10% colocasia leaf powder were also evaluated for preference ratings on a 9 point hedonic scale. The mean scores of the 5 and 10% colocasia biscuits are presented in Table 20. In 2 of the 3 tests, the mean scores of the 5% colocasia biscuit were significantly higher than those of the 10% colocasia biscuits. As each category of the 9 point hedonic scale was given a numerical value for ease in statistical analysis each mean score depicted a position of the sample on the hedonic scale of like extremely (9) to dislike extremely (1). In tests 1 and 2, 10% colocasia biscuits had fallen between the 'like slightly' and 'like moderately' categories while the 5% colocasia biscuits had fallen between 'like moderately' and 'like very much' categories. In test 3, the former biscuits were between the categories of 'neither like nor dislike' and 'like slightly', and the latter biscuits were between the categories of 'like slightly' and 'like moderately'. The results showed that both 5 and 10% colocasia biscuits were on the positive side of the scale. The data were also subjected to trend analysis (Table 21).

Table 19. Trend analysis for composite scoring test scores of 5% and 10% colocasia-malted mix biscuits

Source of variation	Sum of squares	Degree of freedom	Mean square	F value
Total scores				
Biscuits	264.600	1	264.600	7.429*
Error	641.133	18	35.6185	
Trials	81.433	2	40.7165	3.102 NS
Biscuits and Trial	3.1	2	1.55	0.118 NS
Error	472.467	36	13.124	
Appearance				
Biscuits	2.40	1	2.40	1.706 NS
Error	25.33	18	1.407	
Trials	1.002	2	0.501	2.036 NS
Biscuit and Trial	0.128	2	0.064	0.260 NS
Error	8.87	36	0.246	
Texture				
Biscuits	6.66	1	6.66	7.646*
Error	15.67	18	0.871	
Trials	1.23	2	0.615	1.614 NS
Biscuit and Trial	1.04	2	0.52	1.365 NS
Error	13.73	36	0.381	
Taste				
Biscuits	43.35	1	43.35	12.979**
Error	60.16	18	3.342	

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Table 19 contd..

Source of variation	Sum of squares	Degree of freedom	Mean square	F value
Trials	18.53	2	9.265	2.914 NS
Biscuit and Trial	1.6	2	0.8	0.252 NS
Error	114.54	36	3.18	
Leafy flavour				
Biscuit	2.81	1	2.81	0.492 NS
Error	102.7	18	5.71	
Trials	9.43	2	4.72	1.59 NS
Biscuit and Trial	8.64	2	4.32	1.46 NS
Error	106.6	36	2.96	
After taste				
Biscuit	3.75	1	3.75	1.637 NS
Error	41.23	18	2.291	
Trials	3.43	2	1.72	1.116 NS
Biscuit and Trial	3.10	2	1.55	1.006 NS
Error	55.47	36	1.541	
Acridity				
Biscuit	1.35	1	1.35	0.379 NS
Error	64.16	18	3.56	
Trials	1.03	2	0.515	1.192 NS
Biscuit and Trial	0.10	2	0.05	0.116 NS
Error	15.54	36	0.432	

See Table 18 for foot note

Table 20. Means and standard errors of hedonic scale scores

Test No.	Level of colocasia leaf powder in biscuits	Scores	't' values
1.	5%	7.43 ±0.173	3.023**
	10%	6.36 ±0.308	
2.	5%	7.08 ±0.265	1.651 NS
	10%	6.38 ±0.331	
3.	5%	6.85 ±0.296	3.277*
	10%	5.31 ±0.365	

See Table 18 for foot note

Table 21. Trend analysis for hedonic scale of 5% and 10% colocasia-malted mix biscuits

Source of variation	Sum of squares	Degree of freedom	Mean squares	F value
Biscuit	19.27	1	19.27	12.505**
Error	27.73	18	1.541	
Trial	12.70	2	6.35	7.087*
Biscuit and trial	3.03	2	1.52	1.696 NS
Error	32.27	36	0.896	

See Table 18 for foot note

It was observed that the scores of 5% colocasia-malted mix biscuits were significantly higher than that of the 10% colocasia-malted mix biscuits (Table 21), suggesting that the 5% colocasia-malted mix biscuits were preferred over the 10% colocasia-malted mix biscuits. It was also observed that a trend existed in the 3 days' trial (Table 21). The biscuits containing 5% colocasia leaf powder showed a linear and those containing 10% colocasia leaf powder a quadratic trend (Fig 7).

Since both the composite scoring test and hedonic scale preference test indicated that the acceptability of 5% colocasia biscuits tended to be higher than that of the 10% colocasia biscuits, the choice of the level of colocasia leaf powder to be incorporated into biscuits was therefore based on the fact that 100 g of biscuits should provide calcium, iron and beta carotene as close to the recommended daily allowance for a 4 to 6 year old child as possible (Table 22). Based on this criterion it seemed

Table 22. Mineral and vitamin contents[a] of 100 g of biscuits with different levels of colocasia leaf powder as compared to the Recommended Daily Allowance for children (4 to 6 years)

Biscuits	Calcium (mg)	Iron (mg)	Beta carotene (mcg)
Without colocasia leaf powder	66	7.5	110
With 5% colocasia leaf powder	145	12.8	2932
With 7.5% colocasia leaf powder	187	15.8	4346
With 10% colocasia leaf powder	230	18.7	5760
Recommended Daily Allowance 4 to 6 year old child	400 to 500	15 to 20	1200

[a]Gopalan et al (1985)

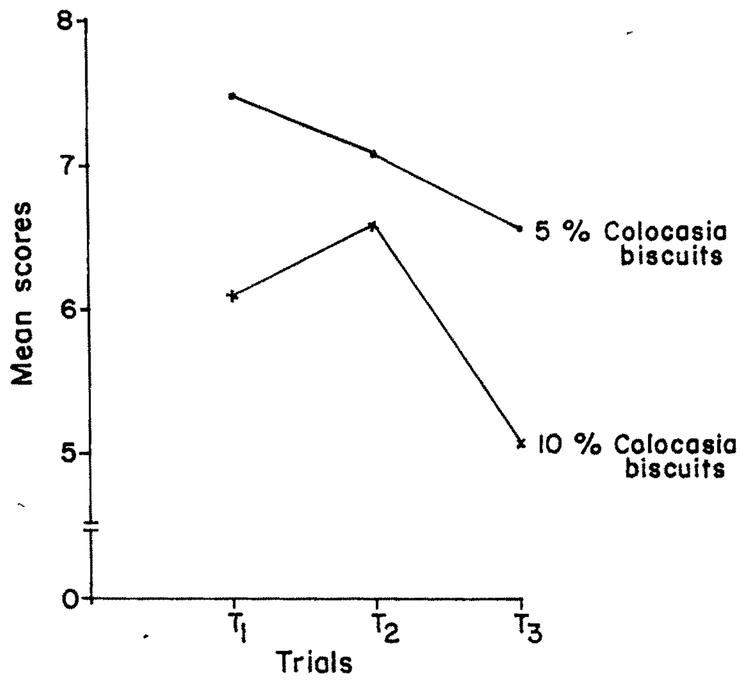

Fig 7. Graphic representation of trend analysis for hedonic scale of 5 and 10 % colocasia biscuits

that incorporation of colocasia leaf powder at 7.5% level into the biscuits would meet the recommended daily allowance of iron and beta carotene and about half of that of calcium. Hence the colocasia leaf powder was incorporated into the biscuits at 7.5% level, 7.5 g powder/100 g dry ingredients.

Acceptability trials of biscuits on 3 to 6 year old children (Final testing)

The acceptability trial was conducted on 75, three to six year old, children of low socio-economic group attending a balwadi, The biscuits were made using the recipe standardized in the laboratory as has been described earlier, from mixes prepared from malted or raw wheat and bengal gram with 7.5% colocasia leaf powder (with malted mix only). Since biscuits were apparently differentiable due to inclusion of colocasia leaf powder which had imparted green colour to the biscuits, all the children were served one type of biscuit each day to avoid curiosity among the children in seeing different coloured biscuits in co-child's plate. The order in which biscuits were tested is outlined below:

Biscuits prepared from raw mix

Biscuits prepared from malted mix

Biscuits prepared from malted mix with 7.5% colocasia leaf powder

Each type of biscuit was evaluated for 3 consequtive days. The data of only 42 children who were regular in attending the balwadi were analysed by analysis of variance (Snedecor and

Cochran 1968). The attendance of children was irregular due to the approaching summer vacations.

The biscuits were served at 10.30 a m, two and a half hours after the school began to function. The children were made to sit in rows with a plate containing 3 biscuits. They were free to ask for more or to leave the biscuits on the plate but were not allowed to take biscuits home. This was to discourage the tendency of the children to eat less in the school and to take biscuits home for their siblings.

Results and discussion

Acceptability of biscuits by children

The acceptability of biscuits was determined by conducting 3 days feeding trial on 3 to 6 year old children. The intake of biscuits at one sitting was recorded.

Table 23 shows that at a sitting, on an average children tended to eat about one biscuit more when the biscuits were prepared from raw mix than when prepared from malted mix or malted mix plus colocasia leaf powder (4.6 Vs 3.8 and 3.9 biscuits). But when the same data were subjected to analysis of variance (Table 24) the results revealed that there were no significant differences in the mean intakes whether raw mix, malted mix or colocasia-malted mix biscuits were offered suggesting that the three types of biscuits were equally acceptable. Table 23 also presents the range of number of biscuits eaten at a sitting. It was observed that children could consume a maximum of 12 biscuits (about 180 g) at a sitting.

Table 23. Mean intakes of biscuits in the 3 days' trial

Biscuits	Mean ± SE
Raw mix biscuits	4.6±0.252 (1 to 10)
Malted mix biscuits	3.8±0.226 (2 to 12)
Colocasia-malted mix biscuits	3.9±0.214 (1 to 8)

Figures in parenthesis denote range of number of biscuits eaten at a sitting

Table 24. ANOVA table for the data of Table 23

Source of variation	Sum of squares	Degree of freedom	Mean square	F value
Between samples	12.45	2	6.225	2.71 NS
Within samples	282.80	123	2.299	

NS = Non Significant

Table 25 presents the pattern of consumption for various biscuits. The intake of biscuits by the children was considered to be consistent when they consumed same number of biscuits for the 3 consequtive days (4, 4, 4 biscuits). It was considered to have increased when the intake increased from a lower number to a higher number (1 to 3 to 4 biscuits) and decreased when the intake of biscuits decreased from a higher number to a lower one (5 to 3 to 2 biscuits). The intake of biscuits was considered to be inconsistent when no set pattern emerged from the data (5, 3, 4 biscuits). Table 25 shows that only 14% of the children were consistent in eating biscuits prepared from raw mix as against 50% children who received biscuits prepared from malted mix with and without colocasia leaf powder. Fifty five percent of the total children reduced intake of raw mix biscuits as against 14 and 2% of those who received malted mix and colocasia-malted mix biscuits. The percentage of children being inconsistent when they were offered raw mix biscuits was higher than when they were offered malted mix and colocasia-malted mix biscuits (19 Vs 17 and 5%). In contrast, the percentage of children who increased their intakes of biscuits was low when raw mix biscuits were offered than when malted mix or colocasia-malted mix biscuits were offered (12 Vs 19 and 43%). These data ensured the consistency of consumption of malted mix biscuits with or without colocasia leaf powder.

The average weight of one raw mix, malted mix and colocasia-malted mix biscuit was about 16 g. The modal intake of biscuits per sitting was 3, it meant that the children consumed mix biscuit would meet one-third of the energy requirement, almost all of the iron, nearly half of calcium and would exceed carotene requirement, thereby indicating the importance of the inclusion of colocasia leaf powder into biscuits.

Acceptability of biscuits with colocasia leaf powder by the mothers.

The objectives of this study were to find out (a) if the mothers found the biscuits acceptable, (b) the consumption pattern of biscuits in families and (c) whether they would buy these biscuits if made available in the market. One biscuit was given to each mother for testing. Forty one mothers were contacted for an interview schedule.

Eighty five percent mothers found the appearance acceptable while the colour was acceptable to only 76% (Table 26). The taste was acceptable to 85% of these mothers. About 93% of the mothers liked the biscuits and 88% thought their children would also like the biscuits. Seventy eight percent of the women said that they would buy these biscuits if made available at the same cost. Seventy three percent of the women said that they would like to prepare the biscuits at home provided they were taught how to make them and the facilities were provided to them. All the mothers were found to use green leafy vegetables in routine family meals because these were liked by the family members and these vegetables added variety to meals. About 42% women had realised that green leafy vegetable was incorporated into the biscuits while the rest were ignorant of this fact.

Table 26. Responses of mothers to the interview schedule

S.No.	Characteristics/Questions	% Response Acceptable/Yes
	Appearance	85.4
	Colour	75.6
	Taste	85.4
1.	Did you like the biscuits?	92.7
2.	Do you think your child will like the biscuits?	87.8
3.	Do you buy biscuits from the market?	92.7
4.	Will you buy these biscuits if these are made available in the market at the same cost?	78.0
5.	Will you like to prepare the biscuits at home if you are taught how to make them?	73.2
6.	Do you use green leafy vegetables in routine family meals?	100.0
	(a) How often	
	(i) every day	7.3
	(ii) twice a week	43.9
	(iii) once a week	34.1
	(iv) any other (sometimes)	14.6
	(b) Why do you use them	
	(i) easily available	
	(ii) rich in minerals and vitamins	
	(iii) cheap	
	(iv) like it and variety	90.2
	(v) do not think before buying	9.8
7.	Did you realize that green leafy vegetable was incorporated into the biscuits?	41.5

Hence from this survey it was clear that biscuits are a common snack in the families. And that the mothers would buy colocasia-malted mix biscuits if made available in the market at the same cost. Green leafy vegetables are also consumed by all the families surveyed. It is only that the women are not aware of their nutritional importance.