IMPACT OF SOY BASED ENERGY FOOD ON THE NUTRITIONAL STATUS AND PERFORMANCE OF ADOLESCENT ATHLETES

By

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THESIS

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I hereby declare that this thesis entitled **"Impact of soy based energy food on the nutritional status and performance of adolescent athletes"** is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

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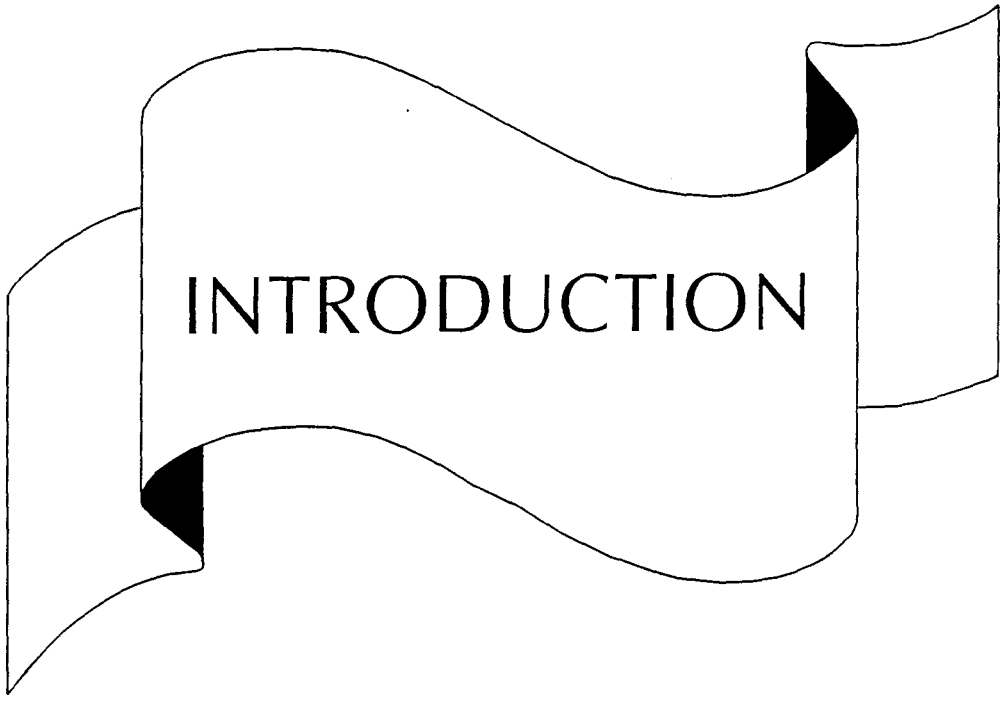

INTRODUCTION

INTRODUCTION

"*You will be nearer to heaven through football than through a study of the Gita. You will understand Gita better with your biceps, your muscles a little stronger, you will understand the Upanishads better and the glory of the atma when your body stands upon your feet and you feel yourselves as men*" says Swami Vivekananda whose preaching depicts the significance of strength for which physical fitness is a prerequisite.

Good nutrition is one of the important factors for athletes but less frequently understood and applied. The better the athletes and faster the competition, the more important is the individual nutritional status. For the last 'split second', that last game super effort in performance good nutrition can make the difference.

Sportspersons should be considered as a special group as far as their nutrient requirements are concerned since they have to maintain an optimal level of nutritional status for maximal performance (Anon, 1987). The athelete, like the non athlete requires a diet that provides suitable proportions of carbohydrate, proteins, fats, vitamins and minerals along with water. The dietary habits that are recommended for good athletic performance are also good for lifetime health and longevity (Grandjean, 1984).

Sports and exercise place an additional and sometimes heavy demands upon the body. According to Fenn (1995) during events like sprint running and swimming the energy expenditure may be as high as 120 times than at rest.

Barton and Smith (1992) recommend an additional amount of calories and protein for good athletic performance. Availability of a suitable energy source which can effectively supplement the existing diet of athletes thus becomes imminent.

According to Rodwell *et al.* (1988) young athletes especially those in their adolescent years are exposed to a wide range of sports activity. They need specific nutritional support primarily to maintain normal growth and physiological maturation in addition to their physical fitness. An ideal body weight and body composition are prerequisitive for good sports performance of these athletes. In a developing country like India where majority of the population is undernourished, the existing deficits in body weight and height of adolescent boys and girls can be compensated if fed on a balanced diet. Ridgway (1994) opined that adolescent athletes have a relatively high level of energy and protein requirements. He recommends the use of a vegetable protein like soy bean as a substitute for meat.

Since animal proteins are inadequate and more costly, it is of great significance to make the best possible use of locally available plant protein. Sobean has been long recognised as an excellent source of

protein (43 per cent). According to Ali (1996) the demand for soybean in supplementary feeding programme is increasing since they promise nutritional security, better health and due to its low cost, it assumes greater significance in India. The protein, calorie, fat, mineral and salt content is greatly enhanced when soybean is blended with other ingredients (Karuna, 1989). Soybean supply essential amino acids closely matched to human needs and athletes can benefit from these rather than relying on expensive meat products (Bean, 1993).

Commercially available health food for sports persons are expensive and little work has been done to study its impact on the health and performance of athletes. Moreover if a soy based energy food could be developed especially for young athletes of Kerala it will help to improve their performance. Hence the present study on "The impact of soy based energy food on the nutritional status and performance of adolescent athletes" was taken up with the following objectives.

i) To develop an energy and protein rich food based on soy for athletes and to

ii) assess the impact of this food on the nutritional status and performance of athletes


REVIEW OF
LITERATURE

REVIEW OF LITERATURE

A study of relevant literature is an essential step to get a good comprehension of what has been done with regard to the problem under study. Such reviews will bring a new insight and will help the development of research procedure. Literature pertaining to the study "Impact of soy based energy food on the nutritional status and performance of adolescent athletes", is reviewed under the following topics.

2.1 Significance of sports nutrition

2.2 Role of soybean as an energy and protein source

2.3 Standardisation, quality assessment and acceptability of new food products

2.4 Supplementary feeding

2.1 Significance of sports nutrition

The international congress on sports nutrition (1990) produced the following consensus statement. Diet significantly influences athletic performance. An adequate diet in terms of quality and quantity before,

during and after training and competition for most sports will maximise performance. In the optimum diet for most sports, carbohydrate will contribute about 60-70 per cent of total energy intake and protein about 12 per cent with the remaining coming from fat. Total energy intake must be raised to meet the increased energy expended during training and maintenance of energy balance.

Sports disturb the chemical balance of the body and it must return back to normal as quickly as possible. Nutrition play an important role in keeping this delicate chemical balance of the body so that the various cells work as an efficient environment (Paish, 1991).

According to Srinath (1999) diet plays an important part in the increase of stamina of the athlete which is an important attribute for the performance of an athlete.

Prolop (1989) noted that negligible mistake in the diet of athletes can ruin many months and years of hard training at the crucial moment.

Daniel and Kulund (1988) opined that poor knowledge of nutrition may contribute to unbalanced nutrition with the athlete being either underfed or overfed.

Garrow and James (1993) opined that children are exposed to a wide range of sports activities and during this period athletic nutrition

plays an important role. Gong and Heald (1988) revealed that young athletes in general have poor dietary habits.

Paish (1991) stresses the need for special nutritional support for sports women to counteract the negative effects of menstruation. Bernardo and Czerwinski (1991) reports energy and mineral deficiencies among women gymnasts. According to Brotherhood (1984) female athletes are much more likely than males to incur nutrient deficiencies. The most significant of these are zinc, iron, calcium, B vitamins and protein.

Fenn (1995) supported the view of Ridgeway (1994) that energy and protein requirements of athletes are high.

In a survey conducted by Mini (1992) at a sports school in Trivandrum it was found that almost all the nutrients were met inadequately and only 85 per cent of the required calories and protein were met.

Physically active persons especially athletes require more fuel and the energy requirements of athletes are much higher than ordinary active person (Bean, 1991). A well balanced diet with increased calories is what athletes need (Durnin, 1990).

Measuring the energy expenditure will provide some of the essential information in the dietary modification of athletes. Cyclists in the Tourde France (an atheletic meet) have been reported to require more

than 6000 k cals / per day, a calorie requirement which is very difficult to achieve by conventional means. Training for competitive sports may increase one's daily energy expenditure by 25-50 per cent (Jang *et al.*, 1987). It has been estimated that total energy expenditure for swimmers and athletes in heavy training, may range from 197 to 357 kj/kg body weight per day (Danzel *et al.*, 1987).

According to Satyanarayana *et al.* (1985) calorie requirements of athletes will be doubled during periods of heavy physical activity. Energy requirements of sports persons vary widely depending upon the intensity of activity involved (Costill, 1988). According to Rao (1996), athletes need 3000 to 6000 kilocalories daily for good performance.

According to Paish (1991) protein needs of athletes are greater than those of sedentary people and a diet low in protein reduces efficiency.

Williams (1994) revealed that exercise has shown to increase protein losses from the body. Greater the intensity of exercise, the greater the loss of protein.

According to Clara (1986), protein requirements for athletes does increase for the development of muscle mass that accompanies exercise.

In a study conducted by Lemon (1991) he concluded that endurance athletes require a higher than normal protein intake probably about twice the usual recommended daily amount.

Brooks (1987) reports that amino acids are used as a fuel source by active muscle. The more intense the exercise and longer its duration, the greater is the contribution of amino acids, to energy producing processes (Elsenmann *et al.*, 1990).

Paul (1989) emphasises the importance of protein during endurance events when carbohydrate sources become exhausted.

Einspahr and Tharp (1989) have reported that after a session of intense exercise at the same relative work load, trained subjects had higher plasma level of alanine compared to untrained ones.

Orioli *et al.* (1990) reveals that protein such as creatine and carnitine are also synthesized by the liver, both of which are responsible for prompt energy balance.

According to Swaminathan (1998) protein is an important nutrient for early wound healing. Fenn (1995) emphasises that protein is an important nutrient for children and teenagers as it is needed for new bone, muscle and skin development. The primary constituent of muscle is protein and 60 to 70 per cent of the protein in the body is in the muscle tissue (Lemon, 1987).

According to Haymes (1983) a protein intake of 1.2 g/kg body weight / day for adults and the protein requirements for adolescent athletes as 1.35 to 1.8 / kg body weight / day (National Research Council, 1980).

Eastwood (1997) reports that carbohydrates in the main nutrient for energy support in exercise, as it is digested and absorbed much greater than fats and protein.

In repeated bouts of intense exercise diets low in carbohydrate have proved to be incapable of restoring tissue glycogen levels (Fredriks and Merrill, 1990).

Sherman (1991) reports that studies have shown poor performance in athletes who eat low carbohydrate diets and they often suffer from fatigue, ketoacidosis and dehydration. Cyclists given carbohydrate feeding before and during exercise maintained glucose concentrations and rates of glucose oxidation necessary to exercise strenuously and thus delay fatigue (Coyle, 1992).

Kiens *et al.* (1990) opined that a diet with is 65-70 per cent carbohydrate was found to be beneficial for swimmers and rowers and is much higher than the 40-45 per cent carbohydrate intake of an average person.

Ben (1991) pointed out that athletes who voluntarily lose weight by controlling their diet should be advised to take enough vitamins in their diet and vitamin requirement would be the same, prior to weight control, during and after.

Mirian *et al.* (1986) suggested that amenorrhoea which may lead to deleterious long time consequences can be prevented with vitamin and

mineral rich diet. Manhan (1984) viewed that athletes have an increased need for water, total energy, carbohydrates, vitamin B complex and protein.

Iron deficiency anaemia is the most commonly encountered deficiency among athletes especially among women as reported by Daniel and Kulund (1988), Wootton (1989) and Eastwood (1997).

2.2 Role of soybean as an energy and protein source

Bean (1993) states that soybeans can be effectively used as a protein supplement for athletes in place of meat in their diet.

Soybean were introduced in India during mid sixties (Sandeep *et al.*, 1993). It has been recognised as a valuable source of protein for feeding both animals and man (Irwin, 1994).

Soybean contains forty per cent of protein of high biological value and twenty per cent edible oil. It is good source of calories, protein, fat and mineral salts (CFTRI, 1992).

Ali (1996) opined that soybeans have a great significance in India as a nutritious low cost food material. According to Das (1992) there is an unlimited number of wholesome snacks for children that can be prepared from soybean.

Soybean contains hardly any starch but it contains carbohydrates in about 30-32 per cent (Kale, 1985). Soybean is also a rich source of iron (Shizuko, 1994).

During the last few decades, there has been an accelerated effort to develop new sources of protein in order to meet the ever increasing requirements of the population (Asharaf Pal, 1998).

Soybean is currently the largest commercially available vegetable protein source in most parts of the world (Natarajan, 1989). Numerous soy products have been developed in India and abroad. These include full fat soy flour (Mishra, 1992), soy milk (Reddy and Mittal, 1992), soy paneer or tofu, soy sphagatti, soy chunks and grits (Patil and Ali, 1990).

Defatted soy flour is a common form in which soybean can be incorporated in various food preparations (Chauhan, 1986). Incorporation of defatted soyaflour will not only enhance the protein content of the diet but also raise its nutritive value (Anita *et al.*, 1994).

Brand and Label (1988) feel that defatted soy flour contains 50 per cent protein unmatched by an other known vegetarian sources.

A fibre content of 9.90 g, ash 7.52 g and protein 53.34 g in soy flour was reported by Raunet *et al.* (1992). It was also found that soy fibre contains 20 to 23 per cent soluble fibre which could help controlling cholesterol.

Soy flour is most attractive in price, quality and quantity and has been extensively studied and recommended for fortifying purpose (Gupta and Sehgal, 1991). The fortified soy flour is used for making a number of soy fortified food items such as biscuits, bread and cookies (Patil and Ali, 1990).

Onweluzo and Iwezu (1998) studied the composition and characteristic of cassava soy and wheat soy biscuits. They found that cassava soyflour biscuits 1:1 proportions had higher protein and calorific values than wheat soy flour biscuits of the same population.

Tandon and Singh (1987) successfully incorporated soy flour into various food preparations like biscuits, chappathi, snacks and textural products.

Studies have shown that addition of 15 per cent soy flour to degermed corn meal and sorghum meal separately increased the protein efficiency ratio. The study also showed that incorporation of the soy flour not only improved the nutritional quality of the sorghum flour but also improved its keeping quality (Jayalakshm and Neelakantan, 1987).

Defatted soy flour due to its exposure to high temperature after oil extraction is found to have higher protein content (Prodencio and Jose, 1993).

Singh and Chauhan (1989) found that noodles manufactured from maida and soy blends were highly acceptable to the consumer. The

feasibility of incorporating soy flour in an extruded food, macroni was studied by Chellammal and Prema (1993).

Chellammal and Prema (1995) processed a multi purpose food with cassava, soy flour and skimmed milk powder. Wheat flour, green gram dhal and soya bean were the ingredients used by Malleshi (1995) for the preparation of protein rich multi purpose food.

A soy ragi multimix formulated by Vijayalakshmi *et al.* (1985) was recommended as a nutritious mix and used as a pre school child snack.

Supplementary food based on rice defatted soy flour and groundnut flour was developed by Sailaxmi (1995) and was found to be highly nutritious.

Patil *et al.* (1984) have reported that soya bean and milk whey in combination provide a low cost nutritious beverage which can be utilized in institutional feeding programmes.

2.3 Standardisation, quality, acceptability and assessment of new food products

Standardisation of recipes is an essential strive for high quality products (Crusius, 1984). The process of recipe standardisation began with process of recipe modification or adjustment (Tolule, 1984).

According to Reay (1983), the advantage of the use of standardised recipes are accurate, cost control, standard buying, issuing

and recording of consistent yield uniformity of size, standard costing and selling price and use of stream lined familiar methods.

The parameters to be considered with standardisation as quoted by Repko *et al.* (1989) and Sareen (1991) are, quality of raw materials, conditions at their preparations and also standardisation on nutritional packing and tabulation agents.

According to Ramdas (1993) standard recipe ensures distribution of work and job satisfaction. It avoids guess work and confusion and helps in training employee in good production. It reduces labour and transportation costs by eliminating inventory shortage and also control raw food costs.

Ritchey and Taper (1981) report the most reliable way to assess the nutritional quality of proteins is through feeding trials.

According to Swaminathan (1989) the quantitative data regarding the relative digestability co-efficient and nutritive value of protein could be obtained only through experiments on animals or human beings.

The quality of soy, fermented soya bean product, fermented soy milk drink and germinated soybean bread were determined by chemical analysis and by animal feeding studies. Results indicate slight increase in essential amino acids content (Khader, 1983).

According to Mc Dermott *et al.* (1992) sensory method in which palatability is evaluated by a panel of judges is essential to every

standardisation procedure because they ensure all important question of the food tastes, smells, looks and touch.

When the quality of food is assessed by means by human sensory organs, the evaluation is said to be sensory analysis. Sensory analysis of food depends upon evaluation through the use of our senses only by applying exact scientific methods (Skeleton, 1984). Ylinaki *et al.* (1989) revealed that sensory analysis is a multi disciplinary science that uses human panelist and their senses to measure the sensory characteristic and acceptability of food products.

According to Mc Lansen (1984), the criteria included in food quality systems are general acceptance taste, appearance texture and aroma of food.

According to Vaidehi *et al.* (1985) high protein biscuits made with ragi and soya flour were found to be both acceptable and nutritious.

The feasibility of incorporating soy flour in extruded food macaroni was studied by Chellammal and Prema (1993) and it was found to be highly acceptable.

2.4 Supplementary feeding

Sheikh *et al.* (1986) developed supplementary food for infants based on blends of rice, wheat and soyabean. Prema and Chellammal (1986) studied the feasibility of incorporating soy flour in weaning food and found that nutritive value has considerably increased.

Patil *et al.* (1984) have reported that soy bean and milk whey in combination provide a low cost nutritious beverage which can be utilized in institutional feeding programmes.

Nagammal (1989) formulated ragi biscuits with different proportions of various ingredients like groundnut, sesame, greengram, butter, skim milk powder besides ragi flour and used as supplementary food for pre school children. The biscuit was found to be well accepted.

Supplementary food based on rice defatted soy flour and groundnut flour was developed by Sailaxmi (1995). It was highly nutritious and improved the nutritional status of pre school children. A high protein beverage based on soy flour was formulated and its impact studied on the selected adolescent children were found to be effective (Litty and Chellammal, 1998).

Subbulakshmi (1990) formulated a milk substitute based on groundnuts and found to promote the growth in children.

Vaidehi (1990) found that a soy bean product produced satisfactory rates of growth in young children and recommended its widespread use as supplementary food.

A special product called REGO contained good proportion of soy protein carbohydrates, mineral and vitamins and was found to be best suited for sports persons (Venkataraghavan, 1998).

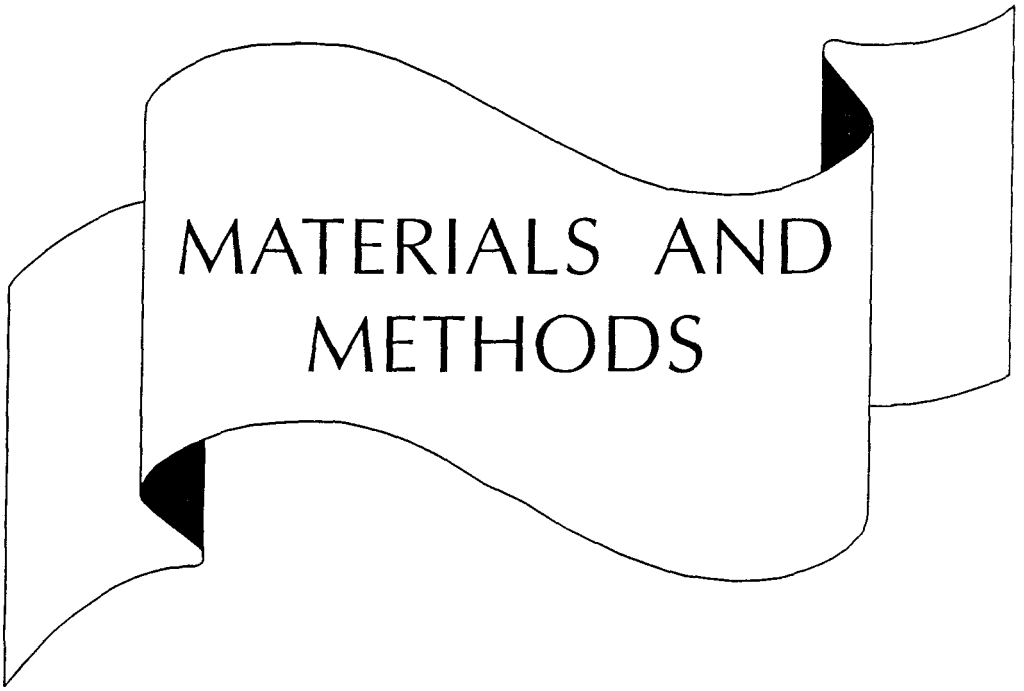
Sindhu and Prema (1995) successfully developed bread, based on soy flour as an effective supplementary food for pre school children.

Harris (1983) was of the opinion that active people can improve their stamina, sports performance and health through the scientific use of food supplements and concentrates. Use of high carbohydrate, high protein, low fat liquid meal like Sustagen and Nutriment on athlete have been studied with positive results.

According to Coleman (1991) small quickly digestible liquid supplements were found useful for athletes. He further reports that under weighed players, track and field athlete who had trouble in maintaining weight and stamina, had good results with liquid meal as supplements.

Paish (1991) opined that standardised strength technique and food supplements such as skimmed milk and protein powdered foods are essential for athletes in some situations.

Amirthreni and Sobha (1995) formulated a cereal pulse based supplementary food in which soya bean was also included. The impact of its feeding on the performance of athletes gave positive results.


MATERIALS AND
METHODS

MATERIALS AND METHODS

The study entitled, "*The impact of soy based energy food on the nutritional status and performance of adolescent athletes*", was carried out on selected adolescent girls engaged in various sports activities.

Plan of Action

The plan of action comprises

3.1 Formulation of an energy food using soy grits

3.2 Standardisation of recipes with the formulated energy food and selection of the best recipe

3.3 Enumerating the impact of the product on athletes through feeding trials

3.1. Formulation of the energy food includes

3.1.1 Selection of raw materials

The raw ingredients selected for the development of the energy food were soy grits as the major ingredient besides milk powder. Wheat,

rice, cassava and sweet potato were the other ingredients tried. The basic criteria for the selection of these ingredients were its nutritional adequacy, organoleptic qualities and economic significance.

Justification for the selected ingredients

Soy grits

Soy grit was used mainly as an energy and protein supplement. Soy girts are soy extruded products made from dehulled soy. It contains 54 per cent protein and 38 per cent carbohydrates (Waggle and Kolar, 1978). Soyabeans with its high protein content is also a good source of calories, fat and mineral salts (CFTRI, 1992). Athletes have accepted soyabeans as a good supplement for meat (Nath and Chibber, 1986).

Skimmed milk powder

Skimmed milk powder is an easily digestible high protein and energy source and at the same time it is low in fat content. Two protein foods, one from plant source and another from an animal source can be used together to improve the protein quality of foods (Hofvander and Cameron, 1983). Moreover skimmed milk powder improves flavour and colour of the product.

Other ingredients

Sinha and Nawab (1993) report that wheat is usually used as the cereal base for supplementing food. It is an important source of energy.

Wheat was tried out in different combinations as refined flour (maida) as well as unrefined flour. Even though maida has better baking qualities, it is nutritionally inferior to unrefined flour especially made from germinated wheat and hence unrefined flour from germinated wheat was selected.

Rice is the staple food of Kerala and an essential ingredient for a variety of breakfast foods. According to Saikia (1990) rice supplies about one third of the required calories to a major Indian population.

Cassava, an important tuber crop of Kerala, is consumed by a large number of people belonging to the low income group here. It has a high calorie content and is relatively cheap.

Sweet potato is one of the world's most important food crop due to its high yield and nutritive value. Kays (1990) revealed the suitability of using sweet potato for making different types of processed foods.

3.1.2 Selection of the best combination for development of the energy food

Ten combinations (C1 to C10) were tried with the ingredient in different proportions for the development of the energy food. These combinations are listed out in Table(1) under (Results) indicating the proportion of the ingredients tried. The principles governing the selection of the most suitable combination were nutritional adequacy, overall acceptability and cost.

The nutritional adequacy of different combinations was ascertained by computing the energy and protein content as well as chemical score.

3.1.2.1 Computing the energy and protein content

Summing method was administered to convert measures of ingredients to correspond weight. These are summed up to determine total grain weight per combination. The energy and protein content of each ingredient was calculated per 100 gm portion (ICMR, 1996).

3.1.2.2. Computation of chemical score

Chemical score of different formulae worked out from the ratio between the content of the most limiting amino acid in the test protein to the content of the same amino acid in egg protein. The ratio is expressed in percentage

$$\text{Chemical score} = \frac{\text{Most limiting amino acid of the test protein}}{\text{Content of same amino acid in egg}} \times 100$$

Chemical scores were computed for the different combinations to access the nutritional adequacy (Appendix I).

3.1.2.3. Evaluation of organoleptic qualities

Overall acceptability of the product was assessed through organoleptic evaluation which was done in the laboratory. According to

Donald *et al.*, (1984) organoleptic tests can be considered as important means for evaluating a new product. The organoleptic quality evaluation was conducted using score cards. The major quality aspects included in the score card were appearance, colour, flavour, texture and taste (Appendix 2). The evaluation was done by a panel of ten judges who were selected using triangle tests Watts (1989) from a group of 30 women in the age group of 20 to 25 years. The testing was conducted in the afternoon between 3 and 4 PM, since this time is considered ideal for conducting the acceptability studies (Swaminathan, 1975).

Cost analysis of the combinations was computed as per market price of the ingredients selected and cost involved in processing.

The combination which secured high scores in all the parameters was selected for the development of the energy food.

3.1.3 Development of the energy food

Soy grits was bought in bulk from Shakthi Soya, Pollachi, Coimbatore, and sundried for two days to remove any trace of moisture. All impurities were manually removed. The grits were later roasted lightly for 10 minutes and milled into fine powder. The flour was sieved through 100 B.S. mesh to remove all impurities as well as to make it uniform.

Initially 5 kg of good quality sugar was purchased from the local super market. The sugar was ground to a fine powder. This was done to

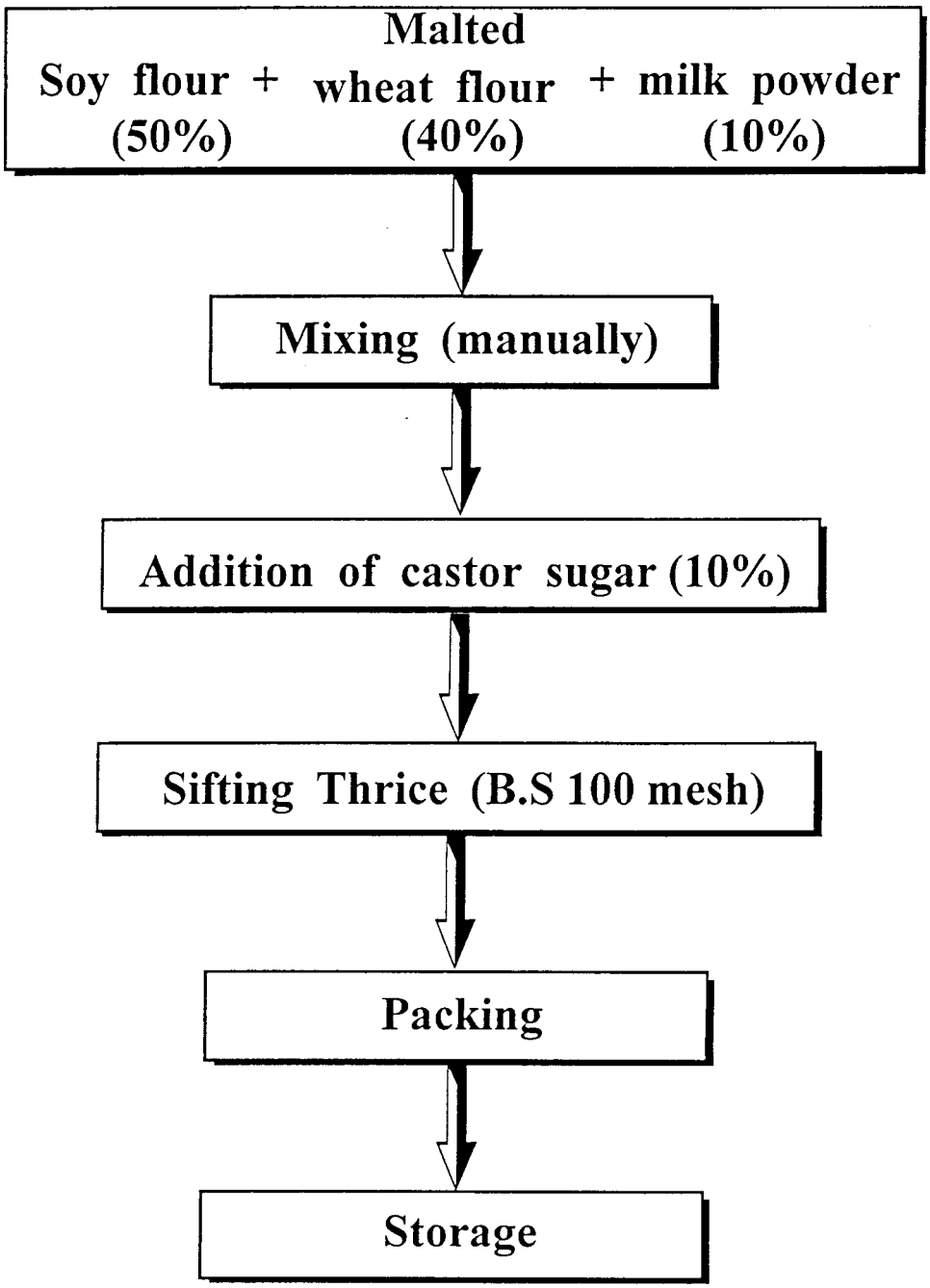


Fig. 1. Flow chart for the formulation of Energy food

facilitate easy blending. Skimmed milk powder was purchased from the super market. Malted wheat flour was prepared by the method suggesed by Litty and Chellammal (1998).

Blend of the selected combination was prepared by mixing soy flour, malted wheat flour, skimmed milk powder and sugar. All the ingredients, after mixing, were sieved three times in order to get uniform mixture, as illustrated in Fig. (1).

3.1.4 Type tests administered to the product

The Bureau of Indian Standard (BIS) has specified certain type tests for various products to maintain quality of processing and marketing.

The type tests pertaining to the product were carried out using standard techniques (IS : 8220-1976).

3.2. Standardisation of recipes

The developed energy food was used for the preparation of biscuits.

Biscuits are essentially a bakery confectionery dried down to low moisture content. These are made from soft flour, rich in fat and sugar and consequently of high energy content (Arnold, 1982). Biscuit was chosen as a supplementary food for athletes because it has better

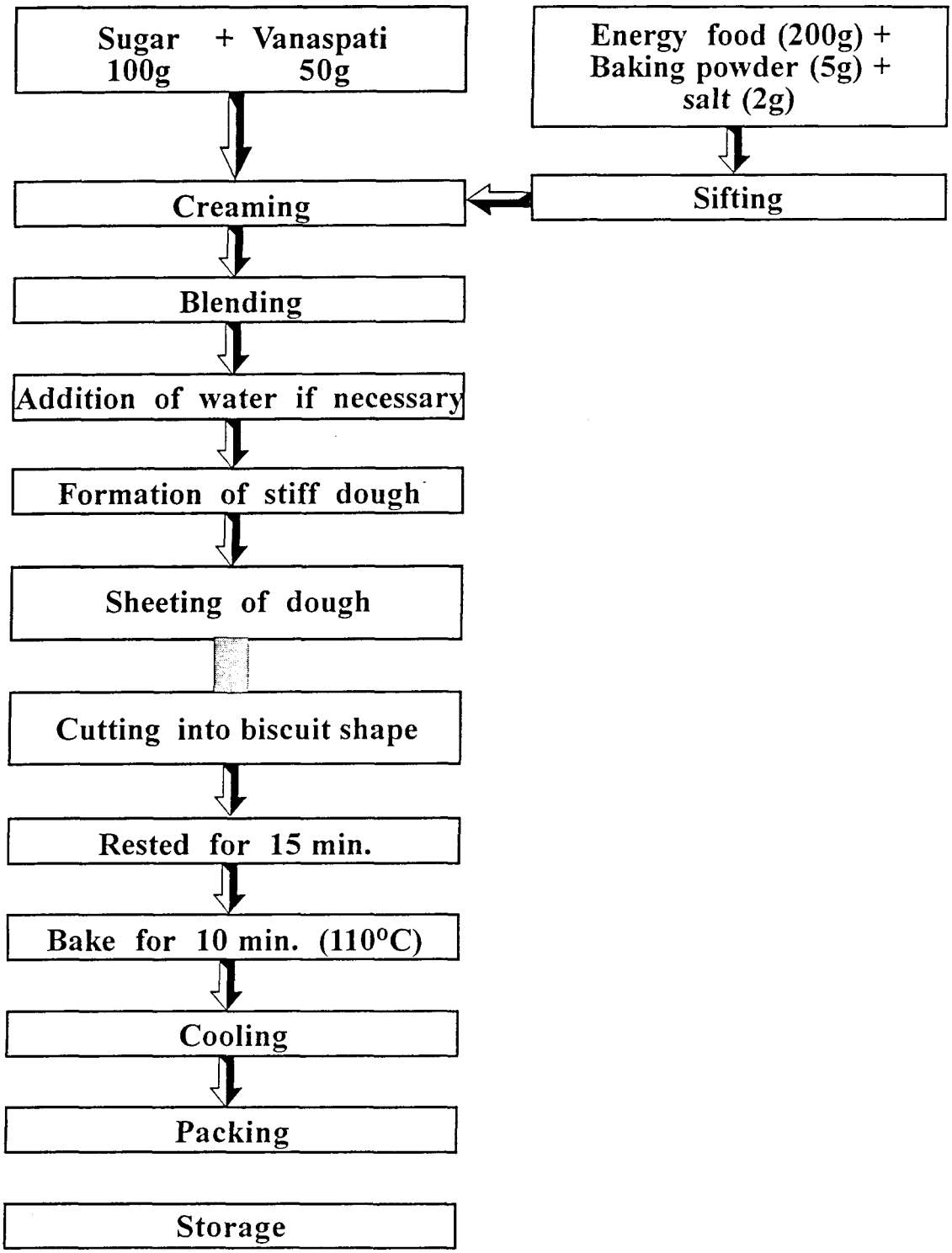


Fig. 2. Flow chart for the development of Biscuit

shelf life and adolescents have an affinity for baked products and moreover it can easily be incorporated into the dietaries of athletes. Biscuits were prepared from a standard recipe suggested by Rhona (1983)as illustrated in Fig (2).

Ten types of biscuits were formulated using the energy food and standardised in the laboratory. They were :

1. Plain biscuit
2. Butter biscuit
3. Chocholate biscuit
4. Coconut biscuit
5. Ginger biscuit
6. Sweet and salty biscuit
7. Dates biscuit
8. Cardamom biscuit
9. Jam biscuit
10. Melt-in-mouth biscuit

The recipes for these biscuits are given in Appendix (4).

3.2.1 Acceptability of the recipes

The acceptability of the product was assessed through organoleptic evaluation by a selected panel of judges using score cards. The major quality aspects included in the score card were appearance, colour, flavour, taste, doneness and texture (Appendix 3).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3.2.2 Preference tests for the recipes

According to Swaminathan (1984) for preference tests a large number of persons are required and based on their judgement their evaluation should come spontaneously.

Preference tests for the ten recipes were conducted among athletes and among sports personnel.

3.2.2.1. Preference test for the recipes among athletes

Fifty athletes were selected at random, the prepared recipes were served to them and they were requested to rank each recipe according to their preference. A scale from nine to one was used, nine representing the optimum. Steps were taken to avoid discussion among them during rating.

3.2.2.2 Preference test for the developed recipes among sports personnels

Experts in the field of sports, coaches, teachers and medical personnel were selected and the prepared recipes were served to them. They were requested to rank the products according to their preference. The rating scale used for this test was same as that used for athletes.

3.2.3 Selection of the most suitable biscuit

The most acceptable and preferred recipe for biscuit was selected for the conduct of feeding trials among athletes.

3.2.4 Type tests administered to the biscuit

Type tests specified by the Bureau of Indian Standards were administered to the biscuit. Estimation of moisture, protein, fat, calories acid insoluble ash and crude fibre were carried out in this context (IS : 7487-1986).

3.2.5 Energy and protein content of the biscuit

The energy and protein content before and after processing of the biscuits were estimated using standard techniques specified by Swaminathan (1984), and Microkjeldahl (ICMR, 1983) respectively.

3.3. Determining the impact of the product among athletes through feeding trials

Conducting feeding trials over a given period of time is considered as the most reliable method to determine the impact of a food.

The feeding trials were conducted with respect to assessing the nutritional status and performance of athletes.

3.3.1 Selection of centre and sample

The Government Sports Hostel for Scheduled Castes and Tribes at Jagathy in Thiruvananthapuram was selected for the conduct of the experiment. The inmates of the hostel were girls engaged in various sports activities like kabadi, khokho, atheletics and swimming apart from continuing their formal education.

Thirty five girls in the age groups of 12-15 years were selected at random.

3.3.2 Conduct of experiment

The experiment was conducted for a period of six months. Every month biscuits was prepared in bulk by the investigator, stored in air tight container and kept at the feeding centres. Each athlete was served three biscuits every day along with breakfast for a period of six months.

3.3.3. Assessing the nutritional status

The nutritional status of the athletes were evaluated with reference to anthropometric measurements, clinical profile and biochemical evaluation.

3.3.3.1 Anthropometric measurements

According to Bhasin and Kapil (1998) anthrompometric measurements are important tools to assess the nutritional status of

adolescent children. Height, weight, chest and arm circumference of the athletes were recorded initially and recorded thereafter every month for six months.

The height is a measure of long standing nutritional status. It was measured using the stadiometer. Weight was measured using bean balance with the athletes wearing very light clothes.

Chest and arm circumferences were measured using flexible fibreglass measuring tape.

3.3.3.2 Clinical profile

According to Swaminathan (1986) clinical examination is the most important part of evaluation of human nutritional status. In the present study the investigator with the help of a qualified physician assessed the clinical profile of the athletes initially and after the completion of the feeding trials The assessment as per the nutrition assessment schedule (NIN, 1986).

3.3.3.3 Biochemical evaluation

Biochemical measurements represent the most objective assessment of the nutritive status of an individual, providing pre or subclinical information. In the present study biochemical evaluation was carried out at the beginning and completion of the feeding programme.

Haemoglobin content (Cyanmethnoglobin method) and serum protein levels (Biuret method) were assessed using standard techniques (NIN, 1983).

3.3.4 Work efficiency and performance tests

The performance tests give an indication of how well the athletes are able to perform after consumption of prescribed diet. The performance was assessed with respect to the specific activity. In the present study the athletes were subjected to the tests initially and after the completion of the feeding trial. The tests include aerobic, anaerobic and strength tests.

3.3.4.1 Aerobic test

Aerobic power is the maximal rate at which an individual can consume oxygen during the performance of all out exhaustive works of exercise. Aerobic capacity of the athletes wre measured by forestry step test. The method for the conduct of the test is given in Appendix 5.

The 15 second pulse count for after the completion of the test and body weight was used to find the maximal oxygen consumption (VO2max.) from the non adjusted fitness norms by Sharkey (1984). Age and VO2 max. values are needed to find their aerobic fitness categories of the athletes as given in Appendix 6. The unit of measure derived from the heart rate response, from Foresty step test is maximal oxygen

consumption value (millimeters of oxygen per kilogram body weight per minute ($mL.kg^{-1}.min^{-1}$).

3.3.4.2 Anaerobic capacity

Anaerobic threshold is the intensity of work load at which anaerobic metabolism is accelerated. Anaerobic capacity is the capacity to perform maximum work in a short burst of high intensity exercise without depending on the oxygen system for energy liberation. Anaerobic power ($P.kgm.s^{-1}$) measured with **Sargent Jump test** (Appendix 7)and the equation to derive this, is expressed as

$$P = 2.21 \times wt \times \sqrt{D} \quad \text{where}$$

2.21 = a constant based upon the rate of fatty bodies

wt = body weight (kg)

D = difference between standing reach and jump height (meters)

3.3.4.3 Strength test

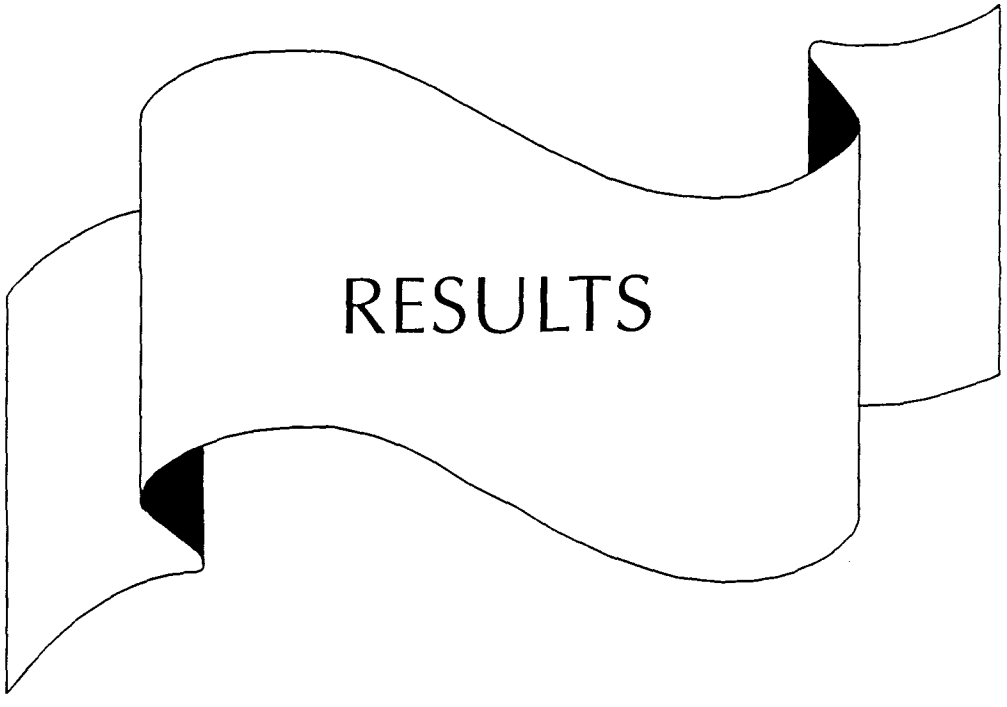
Strength is the maximum amount of force one can exert or it is the maximal pulling force of a muscle group. The most operational definitions of strength is *one repetition maximal* or 1-RM. Thus, the maximal weight that a person can lift only one time is that person's strength. 1-RM can be derived from the equation

1-RM (kg) = kg at RM between 2-20 / [100% - (RM x 2)]

Bench press and **Overhead press** are the two tests conducted for deriving the strength of the athlete. Method for the conduct of these tests are given in Appendix 8.

Statistical analysis

The data generated during the study were compiled and analysed statistically.


RESULTS

RESULTS

The present study entitled, "The impact of soy based energy food on the nutritional status and performance of adolescent athletes", was initiated and the results of the study are presented under the following topics.

4.1. Formulation of an energy food using soy grits.

4.2. Standardisation of recipes with the formulated energy food and selection of the best recipe.

4.3. Enumerating the impact of the product on athletes through feeding trials.

4.1. Formulation of the energy food

4.1.1. Selection of raw materials and different combinations tried

The major raw materials selected for the formulation of energy food were soy grits, milk powder and sugar. Other raw materials tried were malted wheat flour, maida, rice, flour, cassava and sweet potato flour. While selecting the raw materials care was taken to incorporate locally available, low cost as well as nutritionally superior food materials.

The raw materials were combined in different proportions for the development of the energy food. As presented in Table 1, soy flour was added in the proportion ranging from 45 to 60 per cent. Milk powder, selected as one of the essential ingredients was added in the proportion ranging from 10 to 20 per cent.

Table 1. Composition of food ingredients (in percentage) in the different combinations of energy food

Sl.No	Combinations	Ingredients	Proportion
1	C_1	Soy : malted wheat : Milk powder	60 : 25 : 15
2	C_2	Soy : malted wheat : Milk powder	55 : 30 : 15
3	C_3	Soy : malted wheat : Milk powder	50 : 40 : 10
4	C_4	Soy : malted wheat : Milk powder	45 : 40 : 15
5	C_5	Soy : Maida : Milk powder	60 : 25 : 15
6	C_6	Soy : Maida : Milk powder	55 : 30 : 15
7	C_7	Soy : Cassava : Milk powder	55 : 30 : 15
8	C_8	Soy : Cassava : Milk powder	50 : 30 : 20
9	C_9	Soy : Rice : Milk powder	50 : 35 : 15
10	C_{10}	Soy : Sweet potato : Milk powder	55 : 30 : 15

Wheat flour, the third ingredient in the combination was added at 25 to 40 per cent level. Maida or refined wheat flour was also tried at 25 and 30 per cent while cassava flour was utilized at 30 per cent level,

rice and sweet potato flour was added at 35 and 30 per cent level respectively.

4.1.2. Selection of the best combination

Among the ten combinations tried, the principles governing the selection of the best combinations were nutritional adequacy, overall acceptability and cost.

Nutritional adequacy

The nutritional quality of the selected combinations was assessed by computing the calorie and protein content, as well as chemical score.

4.1.2.1. Calorie and protein content

The calorie and protein content of the selected combinations are presented in Table 2. As revealed in the Table, the energy values range from 327 to 412 Kcal per 100 g. Combination C_1 which contained soy, malted wheat and milk powder in the ratio 60:25:15 obtained the highest calorie content. The energy value of C_2 (Soy 55, malted wheat 30, milk powder 15) and C_3 (soy 50, malted wheat 40, milk powder 10) were almost similar securing 410 and 411 Kcal per 100 g respectively. The lowest calorie content of 327 Kcal was obtained for C_{10} which contained soy, sweet potato and milk powder in the proportion 55:30:15. The energy content of C_4 at 407 Kcal was higher that C_5. C_6, C_7, C_8 and C_9 whose calorie value were less than 400 Kcal.

Table 2. Calorie and protein content of the combinations (per 100 g)

Combinations	Calorie (Kcal)	Protein (g)
C_1	412.0	38.9
C_2	410.0	38.2
C_3	411.0	37.0
C_4	407.0	36.8
C_5	400.0	34.3
C_6	396.0	32.7
C_7	393.0	29.8
C_8	389.0	29.5
C_9	390.0	29.3
C_{10}	327.0	29.8

Regarding the protein content of the various combinations C_1 (soy 60, malted wheat 25, milk powder 15) obtained the highest protein content of 38.8g /100 g. It can be observed from the Table that combination which contain wheat as one of the ingredients along with soy and milk powder scored higher protein values compared to those combinations which contained cassava, rice and sweet potato. Combination C_7 and C_8 were found to be on par with C_9 and C_{10} with the protein content ranging from 29.3 to 29.8 g per 100 g.

4.1.2.2. Computation of chemical score

The chemical scores vary from 51 to 91.5 as presented in Table 3. The lowest chemical score of 51 was obtained by combination C_{10} (soy 55, sweet potato 30, milk powder 15). C_1, C_2, C_3 and C_4 were found to be on par with C_5 and C_6. The highest chemical score of 91.5 was obtained by combination C_8 containing soy, cassava and milk powder in the ratio 50:30:20. The chemical scores of C_7 (soy 55, cassava 30, milk powder 15) was found to be same as that of C_9 (soy 55, sweet potato 30, milk powder 15).

Table 3. Chemical scores of the combinations

Combinations	Chemical score
C_1	87.7
C_2	87.2
C_3	85.2
C_4	86.1
C_5	85.0
C_6	83.5
C_7	90.5
C_8	91.5
C_9	90.5
C_{10}	51.0

4.1.2.3. Evaluation of organoleptic quality

Overall acceptability of the combination was assessed through evaluation of organoleptic qualities. The organoleptic qualitiy parameters namely appearance, colour, flavour, texture and taste of the ten combinations were carried out by a panel of ten selected judges using a standard pre-tested score card and the results presented in Table 4.

Appearance

The mean scores for appearance of the ten combinations ranged from 2.6 to 3.6. C_3 with a score 3.6 recorded the highest mean score. It had soy, wheat germ and milk powder in the ratio of 50:40:10. The lowest mean score of 2.6 was obtained by C_{10} (soy : sweet potato : milk powder). While the scores of C_1 and C_9 was same that in 3 mean scores of C_2, C_4, C_5 and C_6 were 3.3, 3.5, 3.3 and 3.4 respectively. Scores of C_7 and C_8 were on par with C_{10}. The scores were found to be significantly different (CD-0.49).

Colour

The scores for colour ranged from 2.4 to 3.8. The highest score of 3.8 was recorded for combination C_9. The lowest score of 2.4 was obtained for C_1 and C_{10}. The scores of C_2, C_3, C_4, C_5, C_6, C_7 and C_8 ranged from 3.0 to 3.7.

Flavour

Regarding the flavour of the different combinations, the mean scores ranged from 2.5 to 3.3. Combination C_3 secured the highest mean score of 3.3. The lowest score was recorded for combination C_1, C_2, C_5 and C_6 with a mean of 3.1 were similar while the mean scores of C_7, C_8 and C_{10} ranged from 2.6 to 2.7. A mean score of 3 was obtained for C_4.

Table 4. Organoleptic evaluation of the combinations

Combination	Mean values				
	Appearance	Colour	Flavour	Texture	Taste
C_1	3.0	2.4	2.5	3.0	2.2
C_2	3.3	3.0	3.1	3.3	2.9
C_3	3.6	3.5	3.3	3.9	3.2
C_4	3.5	3.1	3.0	3.9	2.9
C_5	3.3	3.6	3.1	4.0	2.8
C_6	3.4	3.7	3.1	3.9	3.0
C_7	2.7	3.2	2.7	3.0	2.4
C_8	2.8	3.4	2.6	3.0	2.3
C_9	3.0	3.3	3.2	3.7	3.0
C_{10}	2.6	2.4	2.6	3.0	2.5
F	3.97**	8.17**	4.24**	16.52**	7.76**
CD	0.49	0.44	0.39	0.30	0.34

** Significant at 1 per cent level

Texture

The mean score for the quality parameter texture ranged from 3 to 4. The highest mean score of 4 was recorded for combination 5. Three combinations namely C_3, C_4 and C_6 recorded a mean score of 3.9. The lowest score of 3 was obtained by combinations, C_1, C_7, C_8 and C_{10}. The mean scores of C_2 and C_9 were 3.3 and 3.7 respectively.

Taste

Taste is an important quality parameter. The mean scores for this parameter ranged from 2.2 to 3.2. The combinations C_1 and C_3 got the lowest and the highest mean score respectively score of 3 was obtained for combinations C_6 and C_9. Rest of the combinations namely C_2, C_4, C_5, C_7 and C_8 obtained mean scores ranging from 2.3 to 2.9.

Cost analysis

The cost of different combinations were computed as per the market price of the ingredients selected and cost involved in processing and presented in Table (4). The cost was calculated per 100 gms of the food. The highest cost of Rs. 3.45 was obtained for C_8. The cost analysis of C_1, C_2, C_4 and C_7 were found to be uniform (Rs. 300/100 g). As per the Table combination 7 and 10 were found to be almost equal at Rs. 2.83 and Rs. 2.86 respectively. The costs of C_5 (Rs. 3.10) and C_6 (Rs. 3.12) were comparatively higher than most of the combinations.

The lowest cost of Rs. 2.35 per 100 g was observed for C_3.(soy 50 :malted wheat 40: milk powder 10).

Table 5. Cost analysis of the combinations

Combinations	Cost (Rs/kg)
C_1	3.00
C_2	3.00
C_3	2.35
C_4	3.00
C_5	3.10
C_6	3.12
C_7	2.83
C_8	3.45
C_9	3.00
C_{10}	2.86

It can be concluded from above tests viz., nutritional adequacy, overall acceptability and cost analysis, that no particular combination secured highest scores in all the parameters. C_3 containing soy, wheat and milk powder in the ratio 50:40:10, secured high scores for most parameters and more over its cost of production was lowest (Rs. 2.35/100 g). Hence C_3 was selected for the development of the energy food.

4.1.3. Development of the energy food

One kilogram of the selected combination was taken to which 10

per cent of castor sugar was added to develop the energy food as illustrated in Figure 1.of Materials and Method.

4.1.4. Type tests administered to the energy food

Estimation of moisture, protein, fat, carbohydrates, calories, acid insoluble ash and crude fibre are the major type tests administered to the energy food as per those specified by the Bureau of Indian Standards (BIS) and the results obtained are given in Table 6.

Table 6. Type tests administered to the energy food

Sl.No.	Tests	Energy food	ISI specification
1.	Moisture (% by mass)	5.2	5.0
2.	Protein	31.4	20.0
3.	Fat	13.0	—
4.	Calories (per 100 g)	409.0	350.0
5.	Acid insoluble ash	0.07	0.08
6.	Crude fibre	2.18	3.0

As per the results obtained, the moisture content of the energy food was found to be 5.2 which is slightly higher than the prescribed BIS standard of 5.

The protein content of the food was analysed and found to be 31.4g /100g. This value is much higher than the minimum standard of 20 g specified by ISI. The fat and calorie content of the energy food was 13 per cent and 409 Kcal respectively. There is no BIS specification for fat but the estimated calorie content was higher than the BIS specification of 350 Kcal /100 g. Acid insoluble ash content of the test food (0.07) is well within the maximum limits specified by the BIS (0.08) per cent.

The maximum crude fibre content specified by ISI is 3 but the estimated value for the energy food was lower (2.18).

4.2. Standardisation of recipes

In the present study, ten recipes were formulated based on the energy food and standardised in the form of biscuits. The biscuits were processed using a standard recipe proposed by Rhona,(1983) and variations were made in accordance with each recipe.

4.2.1. Acceptability of the recipes

Acceptability of the developed recipes were assessed with respect to organoleptic evaluation and preference tests.

Table 7. Mean scores for the organoleptic qualities of recipes

Quantity parameters	Plain biscuit	Butter biscuit	Chocholate biscuit	Coconut biscuit	Ginger biscuit	Sweet and salty biscuit	Dates biscuit	Cardamom biscuit	Jam biscuit	Meltin-mouth mouth biscuit
Appearance	4.3	4.6	4.5	4.1	4.0	3.4	4.4	4.5	3.8	3.7
Flavour	3.9	4.4	4.4	3.9	4.2	3.0	4.1	4.0	3.6	3.6
Colour	3.0	4.1	3.0	4.6	3.6	4.2	4.6	4.5	2.7	4.4
Taste	3.8	4.7	4.5	4.1	3.7	2.7	4.2	4.3	4.3	3.7
Donness	4.6	4.8	4.8	4.4	4.8	4.3	4.7	4.5	4.6	4.7
Texture	4.4	4.6	4.8	4.7	4.1	4.3	4.6	4.7	4.6	4.5
Overall acceptability	4.0	4.5	4.6	4.2	3.8	3.1	4.1	4.2	4.3	3.6

The organoleptic qualities of the standardised recipes were assessed by the already selected judges. The quality parameters such as appearance, taste, colour, flavour, doneness and texture were assessed. The scores obtained for the recipes are presented in Table 8.

As per the decision of the panel members, plain biscuit has got a mean score of 4.30 for appearance. For the quality parameter such as colour, flavour, taste and texture, the mean scores obtained are 3.0, 3.9, 3.8 and 4.4 respectively. The highest mean score of 4.6 was obtained for doneness. The overall acceptability score for plain biscuit was 4.0.

Butter biscuit got a mean score of 4.5 for overall acceptability which is the second best among other recipes. Butter biscuit has got a mean score of 4.6 for appearance, 4.1 for colour, 4.4 for flavour, 4.7 for taste, 4.8 for doneness and 4.6 for texture.

For all the parameters except colour, chocholate biscuit secured good scores. The scores obtained for appearance was 4.5, colour 3.0, flavour 4.4, taste 4.5, doneness 4.8 and texture 4.8. The overall acceptability of chocholate biscuit was 4.6 which is the best among all the recipes.

Table 8. Organoleptic evaluation of recipes (Statistical analysis)

Sl.No.	Name of recipes	Mean scores					
		Appearance	Flavour	Colour	Taste	Doneness	Texture
1.	Plain biscuit	4.3	3.0	3.9	3.8	4.6	4.4
2.	Butter biscuit	4.6	4.1	4.4	4.7	4.8	4.6
3.	Chocholate biscuit	4.5	3.0	4.4	4.5	4.8	4.8
4.	Coconut biscuit	4.1	4.6	3.9	4.1	4.4	4.7
5.	Ginger biscuit	4.0	3.6	4.2	3.7	4.8	4.1
6.	Sweet and salty biscuit	3.4	4.2	3.0	2.7	4.3	4.3
7.	Dates biscuit	4.4	4.6	4.1	4.2	4.7	4.6
8.	Cardamom biscuit	4.5	4.5	4.0	4.3	4.5	4.7
9.	Jam biscuit	3.8	2.7	3.6	4.3	4.6	4.6
10.	Meltin-mouth biscuit	3.7	4.4	3.6	3.7	4.7	4.5
	F	3.70^{**}	5.52^{**}	3.40^{**}	6.99^{**}	0.89^{ns}	0.78^{ns}
	CD	0.58	0.95	0.64	0.60	0.52	0.66

** Significant at 1 per cent level

Coconut biscuit obtained an overall acceptability of 4.2. It got a score of 4.1 for appearance, 4.6 for colour, 4.1 for taste, 4.4 for doneness and 4.7 for texture. The lowest score was obtained for taste 3.9.

Ginger biscuit has comparatively low scores for parameters like colour 3.6 and taste 3.7. The score obtained for other parameters were appearance 4, flavour 4.2, doneness 4.8 and taste 4.8. Ginger biscuit obtained an overall acceptability of 3.8.

Sweet and salty biscuit with an overall acceptability of 3.1 was the lowest among the other recipes. It obtained a mean score of 3.4 for appearance, 4.2 for colour, 3 for flavour, 2.7 for taste, 4.8 for doneness and 4.3 for texture.

Dates biscuit scores 4.4 for appearance, 4.6 for colour, 4.1 for flavour, 4.2 for taste, 4.7 for doneness and 4.6 for texture. The overall acceptability of the dates biscuit was 4.1 which showed that it was better than plain biscuit, coconut biscuit and sweet and salty biscuit.

Cardamom biscuit scored 45 for appearance, colour and doneness. It obtained score for flavour as 4.0, taste 4.3, and texture 4.7. Cardamom biscuit got an overall acceptability score of 4.3 similar to that of coconut biscuit.

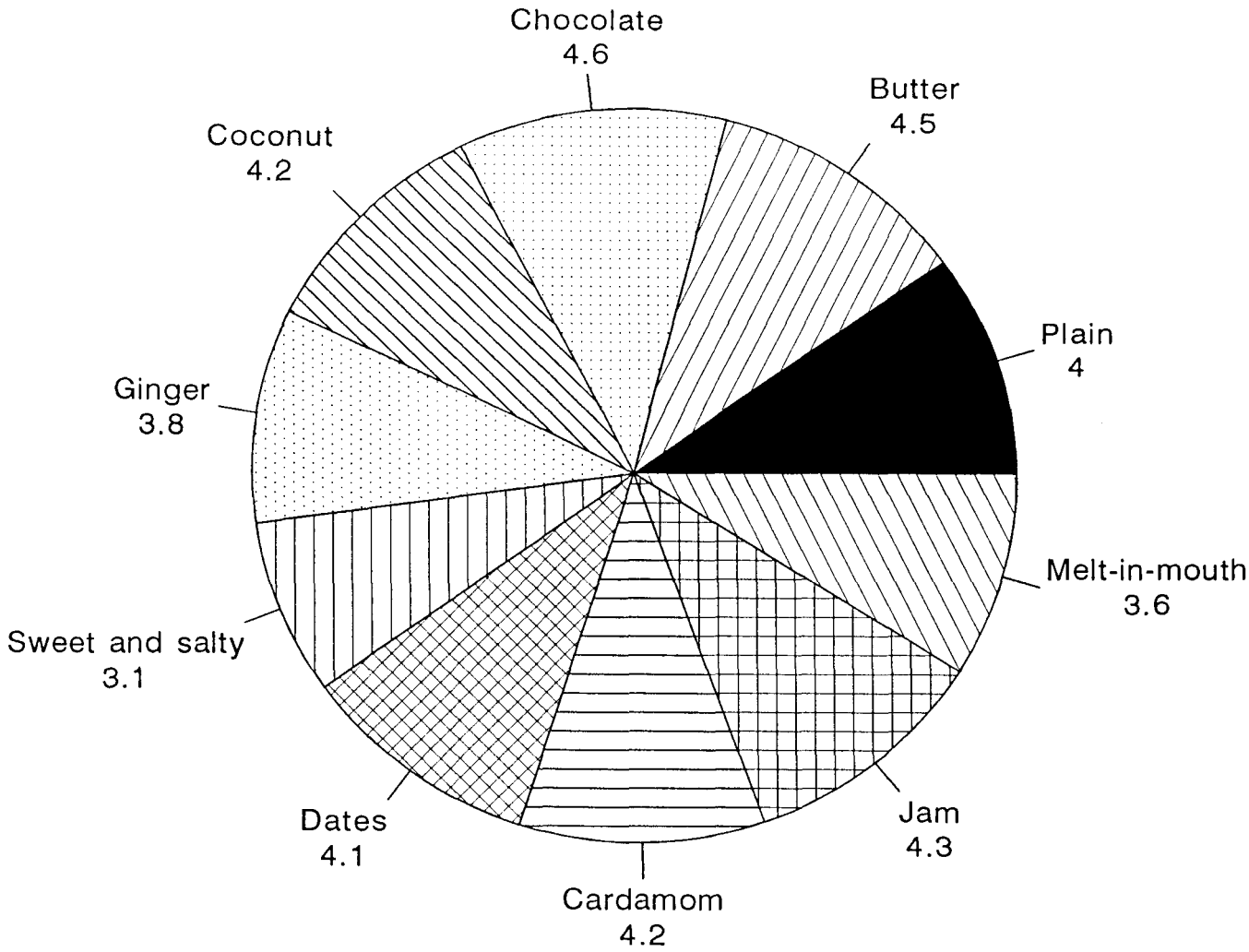


Fig. 3. Overall acceptability of recipes

Jam biscuit with an overall acceptability of 4.3 was the third highest among the recipes. It got a mean score of 4.0, 2.7, 4.0, 4.5 and 4.6 for appearance, colour, flavour, taste, doneness and texture respectively.

The scores obtained for melt in mouth biscuit ranged from 3.6 to 4.7. It secured an overall acceptability of only 3.6. The highest score of 4.7 was obtained for doneness and the lowest for flavour. The scores for appearance, colour, taste and texture were 3.7, 4.4, 3.7 and 4.5 respectively.

Statistical analysis of the organoleptic qualities (Table 8) revealed that there was significant variation in scores obtained for all the parameters except doneness and texture.

4.2.2. Preference test for the developed recipes

During the development of new food product or the reformulation of existing product, the identification of changes caused by processing method by storage or by the use of new ingredients, their acceptability could be assessed by conducting preference tests on a large number of consumers (Watts *et al.*, 1989). Hence in the present study an attempt was made to assess the preference of the athletes, and sports personnel.

The processed biscuits were tasted by them and their opinion on the degree of liking was recorded. Data was collected using a nine point rating scale which varied from like extremely (9) to dislike extremely (1). Since none of the developed foods were rated as 'dislike very much' and 'dislike extremely', these two rating were deleted while discussing the data.

4.2.2.1. Preference among athletes

Among the ten recipes, butter biscuit and chocholate biscuit were most preferred followed by cardamom biscuit (Table 9). Butter biscuit at 46 per cent for "like extremely" and per cent for "Like very much" was the highest preferred. It is closely followed by chocholate biscuit at 43 and 46 pre cent for the first two parameters. Cardamom biscuit at 40 per cent for "like extremely" was also highly preferred.

Jam biscuit and coconut biscuit were ranked positively while jam biscuit scored 38 and 50 per cent, and coconut biscuit scored 32 and 28 per cent for the first two parameters.

Ginger biscuit and plain biscuit got the same rate of preference from the respondents. 20 per cent of the respondents liked them extremely.

Majority of the athletes rated dates biscuit positively. It had a score of 28, 34 and 22 respectively for the first three parameters.

Table 9. Preference scale among athletes

Sl. No.	Recipe	Like extremely	Like very much	Like reasonably	Like somewhat	Do not like or dislike	Dislike somewhat	Relatively dislike
1.	Plain biscuit	10(20)	21(42)	30(15)	4(8)	—	—	—
2.	Butter biscuit	23(46)	20(40)	7(14)	—	—	—	—
3.	Chocholate biscuit	44(22)	23(46)	5(10)	—	—	—	—
4.	Coco biscuit	16(32)	14(28)	11(22)	9(18)	—	—	—
5.	Ginger biscuit	10(20)	12(24)	15(30)	10(20)	3(6)	—	—
6.	Sweet and salty	—	—	7(14)	15(30)	20(40)	7(14)	1(2)
7.	Dates biscuit	14(28)	17(34)	11(22)	4(8)	4(8)	—	—
8.	Cardamom	20(40)	19(38)	10(20)	1(2)	—	—	—
9.	Jam biscuit	19(38)	25(50)	6(12)	—	—	—	—
10.	Melt-in mouth biscuit	8(16)	15(30)	20(40)	5(10)	2(4)	—	—

number in the parenthesis denotes percentage

N = 50

The rating for melt-in-mouth biscuit was 16 percent for 'like extremely', 30 per cent 'like very much' and 40 per cent 'reasonably like it'.

Sweet and salty biscuits were least preferred among the athletes, 14 per cent like it reasonably, 30 per cent like some what. Majority of the respondents (40 per cent) rated it as 'do not like' or 'dislike'.

4.2.2.2. Preference among sports personnel.

In the present study preference tests were conducted by experts concerned directly with sports activities such as coaches, teachers and medical personnel, (Table 10.)

Maximum percentage of respondents rated recipes positively which include parameters such as 'like extremely', 'like very much', 'like reasonably well' and 'like somewhat'. Only a small percentage gave negative rating such as 'do not like' or 'dislike', 'dislike somewhat' and 'dislike reasonably.

All the rated butter biscuit and chocholate biscuit as 'like extremely' and 'like very much'. Majority of the respondents also rated jam biscuit and coconut biscuit positively that 50 per cent 'like extremely', 40 per cent as 'like very much' and 4 per cent as 'like reasonably'.

Table 10. Preference scale among sport personnel.

Sl. No.	Recipe	Like extremely	Like very much	Like reasonably	Like somewhat	Do not like or dislike	Dislike somewhat	Relatively dislike
1.	Plain biscuit	2(8)	10(40)	10(40)	3(12)	—	—	—
2.	Butter biscuit	15(60)	10(40)	—	—	—	—	—
3.	Chocolate biscuit	14(56)	11(44)	—	—	—	—	—
4.	Coconut biscuit	6(24)	6(24)	10(40)	3(12)	—	—	—
5.	Ginger biscuit	3(12)	9(36)	9(36)	2(8)	2(8)	—	—
6.	Sweet and salty buiscuits	—	—	5(20)	12(48)	3(12)	3(12)	2(8)
7.	Dates biscuit	10(40)	8(32)	5(20)	2(8)	—	—	—
8.	Cardamom biscuit	13(52)	8(32)	3(12)	1(4)	—	—	—
9.	Jam biscuit	14(56)	10(40)	1(4)	—	—	—	—
10.	Melt-in-mouth biscuit	6(24)	12(48)	2(8)	2(8)	3(12)	—	—

no in the parathesis denotes percentage

N = 25

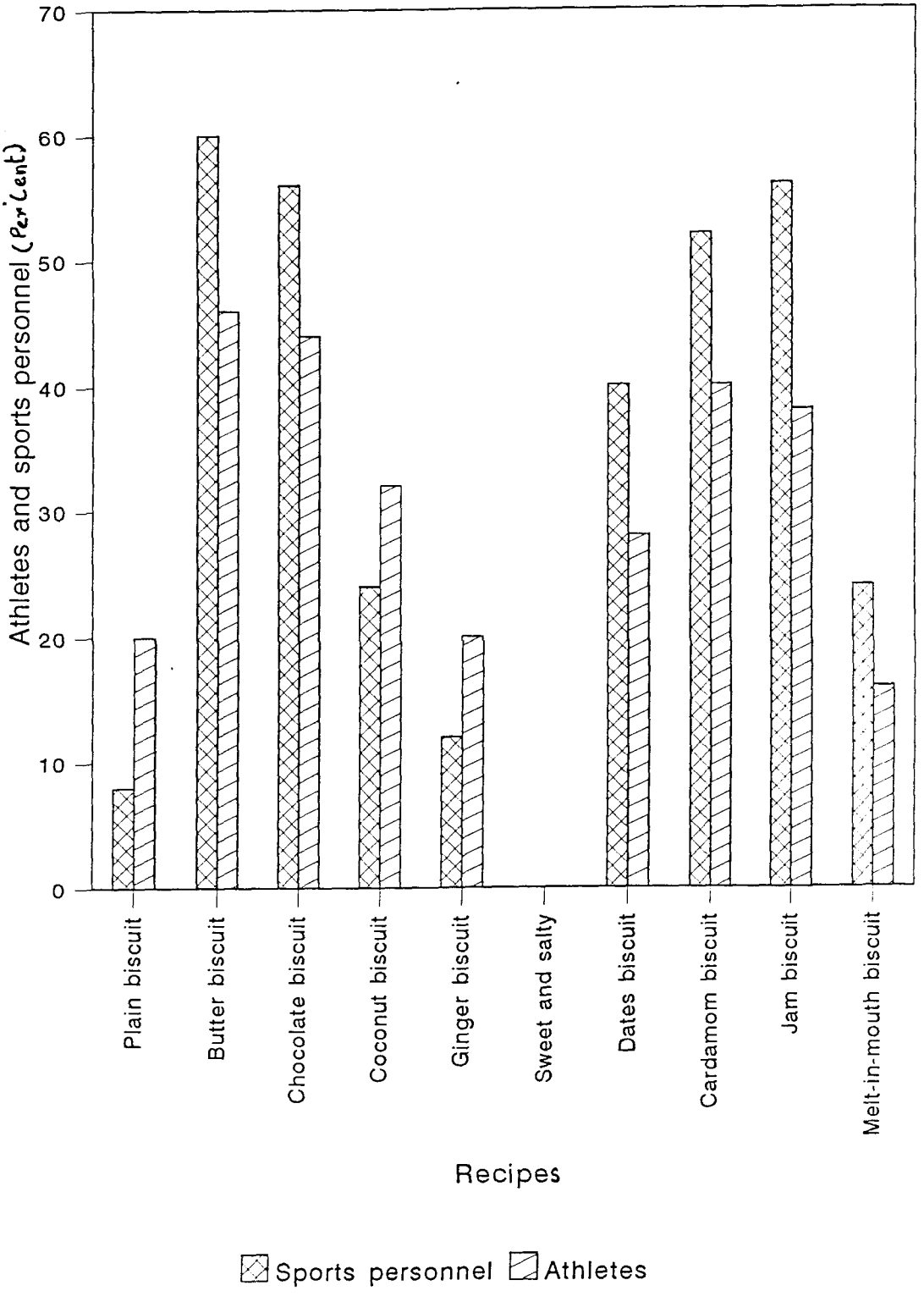


Fig. 4. Preference of biscuits among athletes and sports personnel

Dates biscuit was rated positively by a large number of personnelwhile 8 percent of them rated as 'like some what', melt in mouth biscuit was also rated positively by majority of experts.48 percent of them rated 'like very much', however 12 percent neither liked it or disliked it.

Regarding ginger biscuit, 72 per cent rated it positively, while 12 per cent 'like it extremely'. However 8 per cent like it somewhat and further 8 per cent neither liked it nor disliked. Sweet and salty biscuit was least preferred, as 48 per cent disliked it somewhat and further 8 per cent relatively disliked.

4.2.3. Selection of the most suitable biscuit

It can be concluded from the acceptability tests that butter biscuit and chocholate biscuit secured highest scores for organoleptic qualities and was most preferred among the ten types of biscuit. The cost analysis of these two type of biscuits (Table 11) reveal that chocholate biscuit was more feasible than butter biscuit. Hence chocholate biscuit was selected for the conduct of the feeding trial

Table 11. Cost analysis of biscuits

Sl.no	Biscuits	Cost Rs/Kg
1	Butter biscuit	25
2	Chocalate biscuit	20

4.2.4. Type tests administered

Type tests specified by the Bureau of Indian Standards (BIS) were conducted on the chocholate biscuits for conformation of quality. Estimation of protein, moisture, fat, acid insoluble ash and crude fibre were the major type tests administered.

As per the results obtained (Table 12) the protein content of the biscuit was found to be 33.02 per cent by mass as against 12 of the BIS specification for protein.

The moisture content of the biscuit was estimated to be 5.5 which is within limits of the BIS specification of 6.

It was analysed and found that the fat content of the biscuit was 11 while that specified by the BIS is 12.

Acid insoluble ash in the test material at 1.0 was higher than the BIS specification of 0.08.

The BIS specification for crude fibre is 3.0 while that of the test food was 0.85 per cent.

4.2.5. Effect of baking on the energy and protein content of biscuit

Chocholate biscuit was analysed for its energy and protein content before and after the baking process. The data regarding the detail are presented in Table 13.

The estimation of the energy or calorie content of the biscuit per 100g after baking is 639.3 Kcal while the value before baking was higher at 640.2 Kcal.

The protein content of the biscuit after baking was 33.02 g. The value of protein before baking was slightly higher at 34.03g.

4.3. Impact of the product on athletes

Impact of the energy food on the nutritional and performance of adolescent athletes was studied on 35 adolescent athletes (girls) residing at the sports hostel for scheduled castes and tribes at Jagathy. The selected athletes were between the age group of 11 and 14 years.

The energy food was served to the athlete daily in the form of biscuits. Three biscuits were served to each athlete along with their regular breakfast for a period of 6 months. The effect of the formulated enegy food was assessed with respect to their nutritional status as well as performance.

Table 12. Type tests administered to chocholate biscuit

Sl.No.	Tests	ISI specification	Biscuit
1.	Protein	12	33.02
2.	Moisture	6	6.5
3.	Fat	12	11
4.	Acid insoluble ash	0.08	1.0
5.	Crude fibre	3.0	2.0

Table 13. Effect of baking on energy and protein content of biscuit.

Sl.No.	Nutrients	Before baking	After baking
1	Calories (K cal)	640.2	639.3
2	Protein (g)	34.03	33.02

4.3.3.Assessing the nutritional status

The nutritional status of the athletes was assessed using three main parameters namely anthropometric measurements, clinical profile and biochemical estimations.

4.3.3.1 Anthropometric measurements

Height, weight, chest and arm circumference of the athletes were recorded before the commencement of the feeding trial and at monthly intervals for 6 months. The data collected at the end of feeding trial was subjected to statistical analysis and presented in Table 14.

The initial height of the athletes taken before the feeding trial ranged from 137.5 to 161.5 cm. The final height ranged between 137.7 and 167.7 cm. Table 13 reveals that the mean height values ranged between 151.14 to 151.34. An average increase in height of 0.2 per cent is recorded though this increase is not statistically significant.

Weight profile

Weight is an important index used to determine the current state of nutritional status of an individual.

The initial weight of the athletes ranged from 31 to 51 kg and final weight ranged between 33 to 51.5 kg. Table 14 reveals that mean

weight of the athletes for six months ranged between 41.37 to 43.12 kg. The difference in the initial and final mean weight of the athletes revealed a significant increase. An average increase of 1.75 kg is evident from the Table.

Table 14. Mean scores of height and weight

Sl.No.	Month	Mean	
		Height(cm)	Weight(kg)
0	Initial	151.14	41.02
1	First	151.14	41.38
2	Second	151.18	41.74
3	Third	151.24	42.09
4	Fourth	151.28	42.42
5	Fifth	151.28	42.74
6	Sixth	151.34	43.12

F -0.59^{ns} t value = 16.31^{**}

CD-4.03

ns-not significant

** Significant at 1 per cent level

Chest circumference

As per the result obtained in Table 15 the initial chest circumference of the athletes ranged between 61.5 and 81 cm. The final values that is at the end of the experiment, ranged from 61.7 to 81.2 cm.

The mean chest circumference of the athletes ranged from 74.84 to 75.04 cm (Table 15). An average increase of 0.2 cm is recorded even though it not statistically significant.

Arm circumference

Results obtained in Table 15,revealed that the mean arm circumference ranged between 21.77 and 23.08 cm. An average increase of 1.31 cm was recorded at the end of the feeding trial which was statistically significant.

Table 15. Mean scores of chest and arm circumferences

Sl.No.	Month	Mean	
		Chest circumferance (cm)	Arm circumferance (cm)
0	Initial	74.84	21.77
1	First	74.84	21.77
2	Second	74.87	21.90
3	Third	74.93	21.96
4	Fourth	74.97	22.04
5	Fifth	75.01	22.10
6	Sixth	75.04	23.08
	F	1.3	0.88**
	SE	0.76	0.24
	CD	2.11	0.67

* significant at 1% level

Comparison of anthropometric measurements with standard.

Comparison of mean height for age data of the athletes with standard is presented in Table 15. The initial mean (149.8cm)and final mean height (149.9 cm) were found to be higher than the standard height (136.7cm)for girls in the age group of 12 years. A similar result was observed for 13 year age group.In the 14 year old category even though the initial mean height was slightly less (150.4 cm), and the final mean value was comparable to the standard (150.6 cm).

Table 16. Comparison of mean height for age of athletes with standard

Age Yrs.	sample size	observed average height (cm) initial	final	standard weight (cm)
12	12	149.8	149.9	136.7
13	9	154.6	154.8	141.0
14	14	150.4	150.6	150.6

Weight for age in comparison with standard are presented in Table 17. .In this category the initial and final mean weight of athletes in the age group of 12, 13 and 14 years was significantly higher than the standard mentioned. The final mean values for weight obtained after the completion.

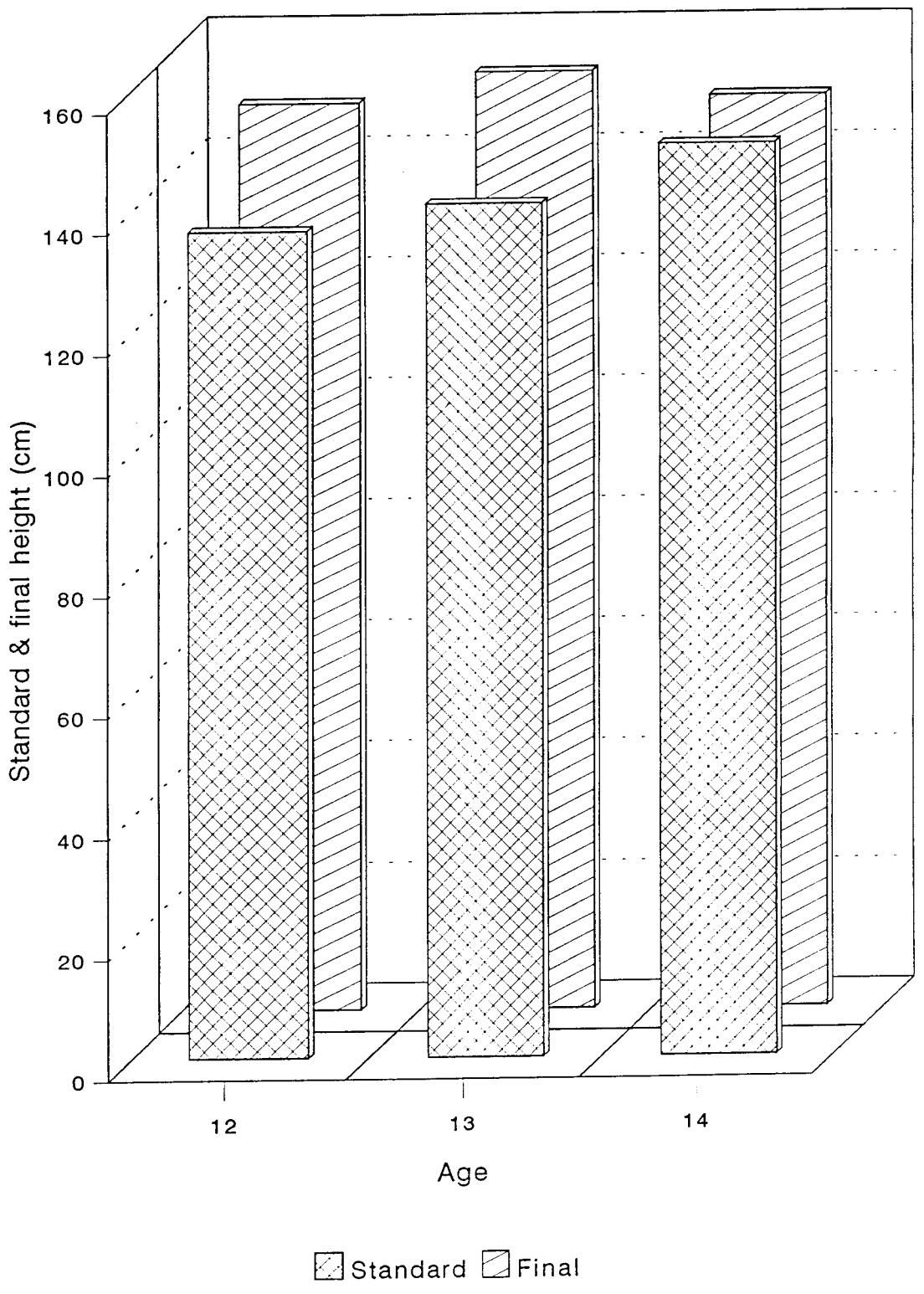


Fig. 5. Comparison of mean height for age of athletes with standard

of the feeding were 40, 45.8 and 44 for the three age group, while the standards were 28.5 , 31.4 and 41.2 respectively showing a significant difference.

Table 17 .Comparison of mean weight for age of athletes with standard

Age Yrs	sample size	observed average weight (kg) initial	final	standard weight (kg)
12	12	38.1	40.0	28.5
13	9	44	45.8	31.4
14	14	42.4	44	41.2

Comparison of mid arm circumference of the athletes with standard is presented in Table17. The initial mean (21.6 cm) and final mean (22.6 cm) arm circumferances of the athletes in the age group were found to be significantly higher than the standard of 18.5 cm. Initial (21.4 cm) and final (23.1 cm) mean arm circumferances for age group of 13 year was also significantly higher than the standard of 19.0 cm. In 14 year age group, the initial (22.1 cm) and final (23.3 cm) mean arm circumferances were slightly higher than the standard.

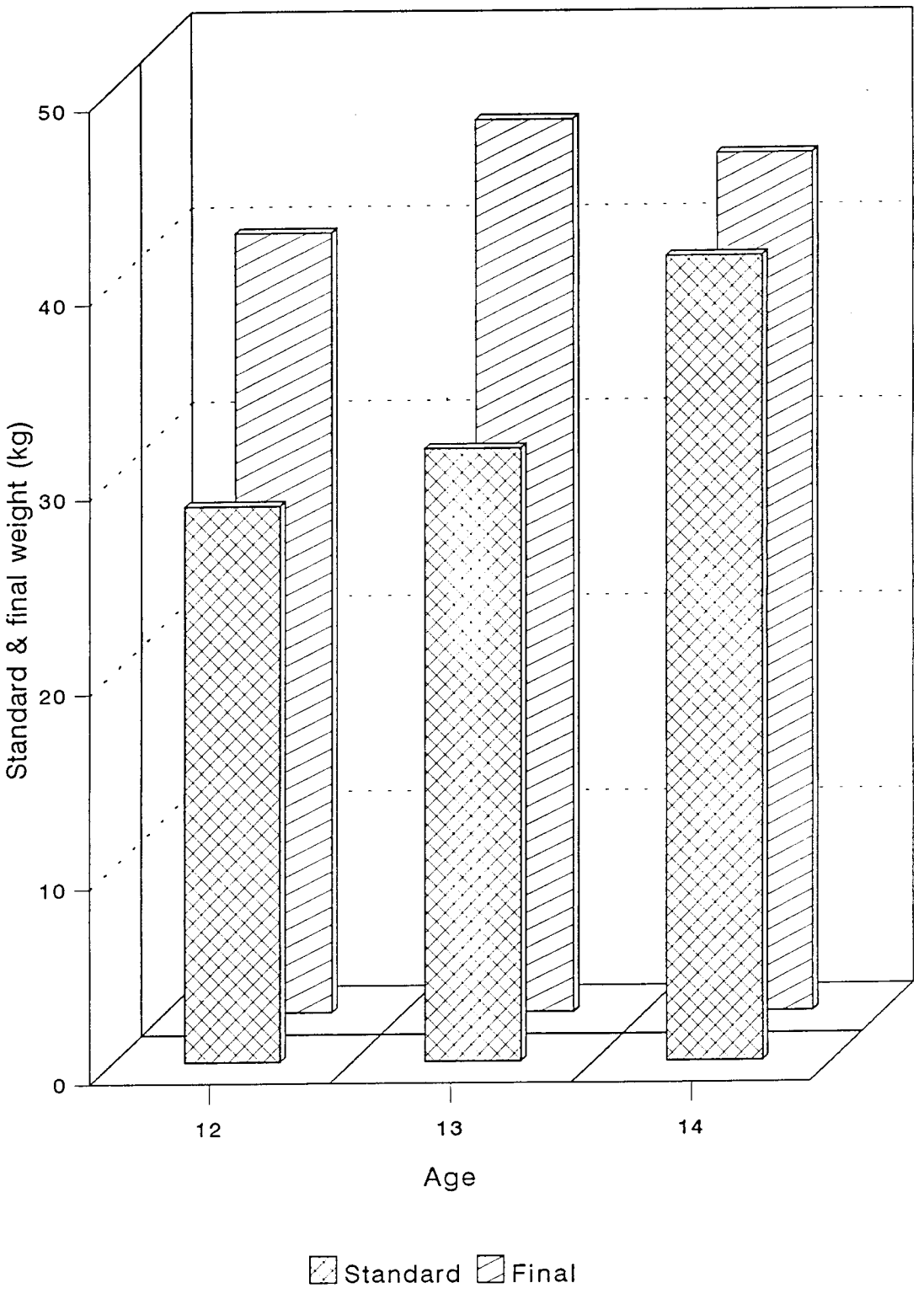


Fig. 6. Comparison of mean weight for age of athletes with standard

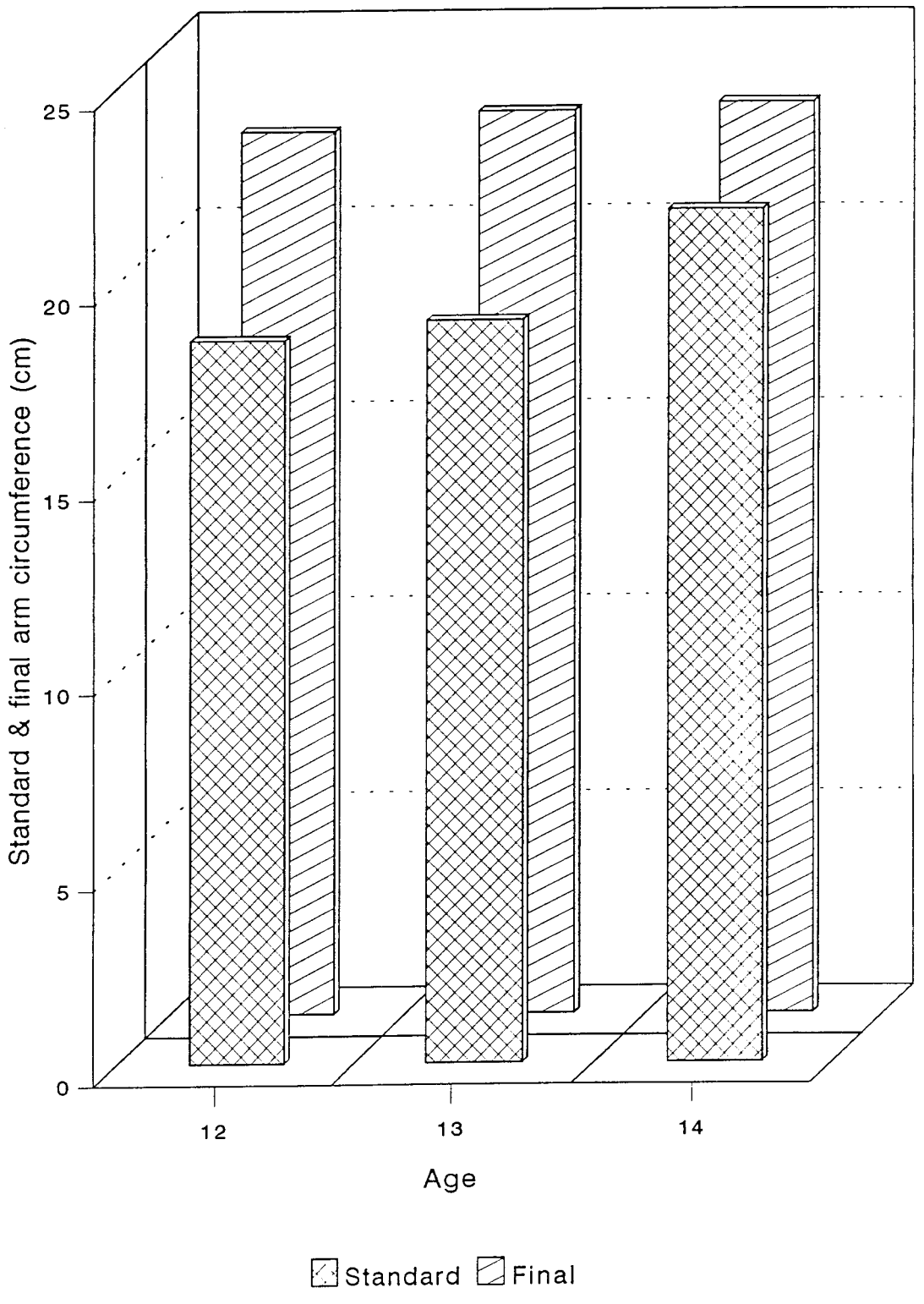


Fig. 7. Comparison of mean arm circumferance of athletes with standard

Table 18 Comparison of mean arm circumferance with standard

Age Yrs	sample size	observed average arm circumferance (cm) initial	final	standard arm circumferance (cm)
12	12	21.6	22.6	18.5
13	9	21.4	23.1	19.0
14	14	22.1	23.3	21.8

Body Mass Index of the athletes

The ratio of weight in kilograms by height square in metres is referred to as body mass index or Quetlet's index (Rao and Singh),1970. Body mass index (BMI) of the atheletes was calculated initially and after the completion of the feeding trial. The details of the results are presented in Table 19.

The initial BMI of the atheletes between 15.12 and 21.07 and after the completion of the feeding there was an increase in the BMI ranging between 15.45 and 22.29. Initially the percentage of atheletes suffering from chronic energy deficiency (CED) was 68.12 per cent and those with normal BMI was 31per- cent. A noted change could be observed after the completion of the feeding where CED was reduced to 42 per cent while those with normal BMI increased from 31per cent to 57 per cent.

Initially 12,17 and 40 percent of athletes suffered grade III ,II & I CED respectively. Final results indicate 3,17, & 23 percent suffering from Grade III , II & I CED respectively. A noticeable improvement in the BMI could be observed in this category. None of the athletes was found to suffer from obesity

Table 19. BMI of the athletes

BMI class	Initial		Final	
	Number	Percent	Number	Percent
< 16.0	4	12.0	1	3
16.1-17.0	6	17.0	6	17
17.1-18.5	14	40.0	8	23
18.5-25.0	11	31.0	20	57

BMI class	Presumptive diagnosis	
< 16.0	Chronic energy deficiency	Grade III(severe)
16.1-17.0	CED	Grade II (moderate)
17.1-18.5	CED	Grade I (mild)
18.6-25.0	Normal	
>25	Obesity	

Source NNMB,1991

3.3.2 Clinical profile

Clinical examination was conducted as per the nutritional assessment schedule through which direct information of signs and symptoms of dietary deficiency prevalent among the athletes was assessed. The clinical examination was conducted by a registered medical practitioner at the start and after completion of feeding trial.

Table 20 reveals that the athletes were free of most of the deficiency symptoms except anaemia, tongue papillae, knock-knees, teeth molted, thyroid and lymph enlargement. 83 per cent of the athletes were suffering from one or two of the above symptoms while the remaining 17 per cent were free of any clinical symptoms. 31 per cent of athletes had anaemia, 34 per cent had knock-knees. While 9 per cent athletes suffered from thyroid enlargement, 3 per cent each suffered from molted teeth, tongue papillae and lymph enlargement.

After the completion of the feeding, the number of athletes suffering from anaemic symptoms was reduced from 31 to 17 per cent. The athletes possessing knock-knees remained the same. There was no case of molted teeth and tongue papillae after the feeding. Athletes suffering from thyroid enlargement remained same, however there was no case of lymph enlargement among the athletes.

Table 20. Clinical profile of the athletes

Clinical symptoms	Initial		Final	
	Number	Per cent	Number	Per cent
Anaemia	11	31	6	17
Tongue papillae	1	3	—	—
Knock knees	12	34	12	34
Teeth molted	1	3	—	—
Tyroid enlargement	3	9	3	9
Lymph enlargement	1	3	—	—

6 athletes (17 per cent) were free from any of the deficiency symptoms.
n = 29

4.3.3.3 Biochemical evaluation

Biochemical parameters such as serum protein and haemoglobin were assessed initially and after the completion of the feeding programme. For this purpose 5 ml of blood sample was drawn from each athlete and subjected to chemical evaluation. Details of the data are presented in table 21.

The serum protein levels of the athletes initially ranged between 6 and 7.6.After the completion of the feeding, the serum protein level ranged from 6.20 to 7.67 g. 25 percent of the athletes have serum protein below normal level.Details in Table 21 reveal that the mean initial serum protein level was 6.83 while the final mean value was 6.98 g. There is a mean increase of 0.15 g. in the serum protein level of the athletes

Haemoglobin content in blood samples of the athletes were measured using the cyanmethmoglobin method . The initial haemoglobin estimates of the athletes revealed that 82 percent of them were aneamic, with only 17 percent of them having normal haemoglobin levels.The initial haemoglobin values ranged between 8.8 and 12.6 g./dl. after the completion of the feeding trial the haemoblobin level ranged from 9 to 12.7 g/dl.

As indicated in Table 21 the mean initial haemoglobin was 10.65 while the final mean value of Hb content is 10.83. A significant increase of 0.18 per cent was recorded after the completion of the feeding.

Table 21. Haemoglobin and serum protein level of the athletes

	Mean		
	Initial	Final	t value
Haemoglobin g/dl	10.65	10.83	11.39**
Serum protein gm	6.83	6.98	4.78**

** Significant at 1 per cent level

4.3.4. Work efficiency and performance tests

Specific tests were conducted to assess the performance of the athletes after the incorporation of the energy food. The tests were conducted initially and after the completion of the feeding. A comparison of the initial and final values was done using 't' test of statistical analysis. Tests include aerobic, anaerobic and strength tests.

4.3.4.1. Aerobic test

Maximum oxygen consumption rate that is aerobic capacity of the athletes were assessed through forestry step test and the data pertaining to the test is given in Table 22. The two important parameters from which the fitness category of the athletes derived were the pulse rate and VO_2 max.(maximum volume of oxygen consumed). The initial pulse rate of the athletes ranged from 38 to 55 and final pulse rate ranged between 20 and 30. The initial VO_2 max. ranged between 38 to 55 and the final between 40 an 61.

The mean initial pulse rate stands at 28.03 and the final at 26.73. A significant change is recorded in the pulse rate. The initial mean VO_2max. was 45.75 and the final mean VO_2 max. of 47.59 also recorded a significant change.

Table 22. Non adjusted aerobic fitness values (mL.kg $^{-1}$.min $^{-1}$)

	Mean		
	Initial	Final	't' value
15 s* Pulse rate	28.03	26.73	7.78**
VO_2 max.	45.73	47.59	8.13**

*second

** Significant at 1 per cent level

The VO 2 max. derived from the non adjusted fitness value was used to determine the age adjusted aerobic fitness categories of the athletes . The details of the data is presented in Table.22

The fitness category included in the Table were superior, excellent, very good, and fair. Since none of the athletes were rated poor or very poor, these two categories were deleted from discussion. It can be observed from the table that initially only 3 percent of the athletes were in the superior category, which increased to 9 percent in the final. In the excellent and very good categories the initial 15 and 50 percent respectively were raised to 18 and 53 percent respectively. 3 percent of the athletes were rated as fair in the initial while none was present in the final.

Table 23. Age adjusted aerobic fitness catagories of athletes.

Sl.no	Category	Initial		Final	
		number	percent	number	percent
1	superior	1	3	3	9
2	excellent	5	15	6	18
3	very good	17	50	18	53
4	good	10	29	7	20
5	fair	1	3	-	-

4.3.4.2. Anaerobic test

Sergent jump test through which the aerobic capacity of the athlete is measured was conducted and the data is presented in Table 24.

The power of each athlete (P=2.21 x wt x D) was derived for two categories that is D-value and the corresponding weight of the athlete. The initial power (P) derived from D value and weight ranged between 38 and 70 kgms. The final P ranged between 39 and 72 kgms.

The mean initial D value stands at 0.33 and the final at 0.34. The change was statistically insignificant. The initial mean weight of the athletes is 41.37 and final mean value is 43, and the change was statistically significant.

The mean initial power of the athletes is 50.6 and the final mean P value is 54.91 kgms. There was significant difference in the initial and final values.

Table 24. Mean values for sargent jump test

	Mean		
	Initial	Final	't' value
D value	0.35	0.34	1.816^{ns}
Weight (kg)	41.02	43.12	16.31^{**}
Power (P) (2.21 x wt x / D) $kgm.s^{-1}$	40.6	54.91	5.62^{**}

** Significant at 1 per cent level

Strength Test

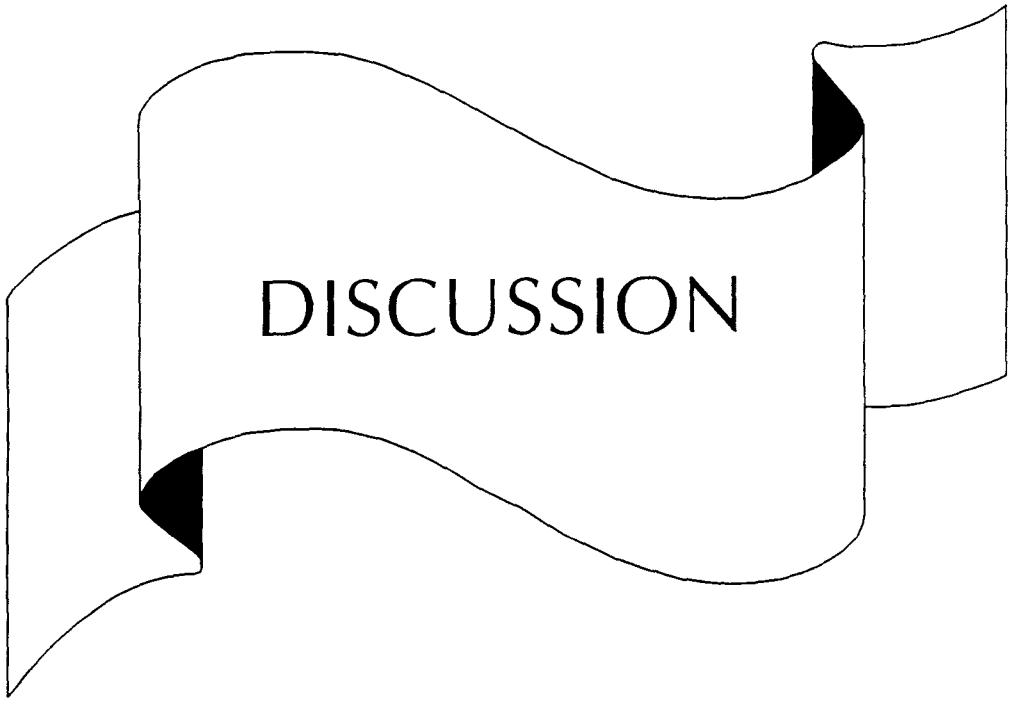
Strength was determined by calculating 1-RM (one repetition maximal). Bench press and Overhead press were the two free-weight exercise by 1-RM was calculated (Table 25).

The initial 1-RM values for the bench press test ranged between 17 and 25 while final mean values between 18 and 27. There is a statistically significant difference in the initial mean (20.2) and final mean (22.01) in 1-RM of the Bench press test. Regarding Overhead test a statistically significant difference in the initial mean (20.31) and final mean (21.30) in 1-RM values has also been observed.

Table 25. Mean values for strength Test

Test	Mean (1-RM) Initial	Final	't' value
Bench Press	22.2	22.0	6.18**
Overhead Press	20.3	21.3	7.03**

** significant at 1 per cent level.


DISCUSSION

DISCUSSION

The study on Impact of soy based energy food on the nutritional status and performance of adolescent athletes was undertaken to develop a high calorie supplementary food for adolescent athletes. According to Long (1999), Indian athletes unlike their western counterparts are often crippled due to waning energy levels triggered by low nutritional inputs. Hence the need to develop an energy food was felt. The impact of the food on the nutritional status and performance of adolescent athletes was assessed and the salient finding of the study are discussed below.

Formulation of energy food based on soy grits

Significant progress has been made by food industries in our country in recent years in the area of new development of food products (Rao, 1993). The raw materials selected for the development of any food play important role in determining the quality of a product. Combining different ingredients in a product is also as important as the nature and properties of its ingredients. Soy grit was included in the combination as the main ingredient. According to Krishnan (1994) soy grits and chunks are manufactured from defatted soy flour using extrusion cooking. The use of these textured products are becoming increasingly popular.

Nutritionally soy bean has a very high protein content (43 per cent) and when blended with other ingredients increases the protein, calorie and fat content (Jayalakshmi and Neelakantan, 1985). According to Joshi and Vaidehi (1998) flour made from defatted soy flakes have a protein content of 52.5 per cent and more.

Wheat was incorporated in the combination as malted wheat and as refined wheat flour (maida). Sinha and Nawab (1993) have reported that wheat is usually used as the cereal base for supplementary foods. More over wheat based food constitute the important source of energy and other nutrients (Kent and Evers, 1994).

The use of malted wheat instead of whole wheat flour was due to the fact that germinating improves the nutritional quality of foods. According to Leelavathi *et al.* (1990) germinating wheat improves its baking quality.

Maida or refined wheat flour is extensively and traditionally used in the preparation of various baked items like biscuits, cakes, crackers and breakfast items. Even though it is a good source of energy it is nutritionally inferior to unrefined wheat flour.

The inclusion of cassava as an ingredient in the combination was tried because it is economically and specially one of the most important crops in Asia especially in Kerala (Kunalaningrih, 1992). Since it is

mainly a carbohydrate food, it can be used in place of cereals partly supplemented with protein.

Rice is an important staple food consumed by more than half of the world's population. It supplies on an average, one third of the calorie requirement (Saikai, 1990).

The increasing popularity of sweet potato based products was the reason for its inclusion of sweet potato as an ingredient in the combinations. In addition to its starch content, it also contains various sugars, minerals and protein with all essential amino acids.

The ingredients were combined in ten different proportions and the best combination was selected on the basis of nutritional adequacy, overall acceptability and cost. The nutritional adequacy was assessed by computing the calorie and protein content as well as the chemical score of the ten combinations.

It was observed that calorie content of the combinations varied from 327 to 412 kcal per 100g. Those combinations (C_1, C_2, C_3, C_4) with malted wheat as an ingredient contained higher energy values while the other combinations contain below 400 kcals. The reason for the high calorie content may be because wheat germ (443 kcal/100g) is an excellent source of energy and when combined with soy and milk powder raises the calorific value considerably. Asiedu *et al.* (1993) have shown that germination increased the gross energy values of cereals.

Regarding protein content of the various combinations, a similar result can be interpreted. The protein content of combinations C_1, C_2, C_3 and C_4 ranged between 36.2 to 38.9g per 100 g. C_5 and C_6 which contain maida were found to be on par with the above combinations. Nikolic and Salihodzic (1988) have stated that the addition of soy flour greatly increased the protein content of the products.

Chemical scores of the various combinations varied from 51 to 91.5. There is no uniformity regarding the chemical scores of the combinations. Higher chemical scores were recorded for C_7, C_8, C_9 which contained cassava and rice as an ingredient. C_{10} which contains sweet potato obtained lowest chemical score of 51. Theoretically, combinations which have chemical scores below 75 per cent are nutritionally inferior and hence C_{10} was discarded from selection. The chemical scores of C_1, C_2, C_3 and C_4 though not the highest were found to be good.

Since chemical scores alone could not be considered a basis for the choice of the best combination, they were subjected to organoleptic evaluation to assess its overall acceptability.

Organoleptic qualities can be defined as qualities effecting a bodily organ or sense particularly of the combination of taste and aroma (Sindhu, 1995). Sensory evaluation of food is assumed to be of increasing significance as this provides information which may be utilized for

development of a product and its improvement. Quality parameters such as appearance, colour, flavour, texture and taste are assessed by means of human sensory organs.

The organoleptic qualities of the ten combinations were carried out in the laboratory by ten selected judges. According to Watts *et al.* (1984) the information on the specific sensory characteristics of a food must be obtained by product oriented tests.

Appearance is a composite of all information about the product and its environment which reaches the eye (Birch *et al.*, 1988). The score for appearance of C_3 was superior to all other combinations while C_2, C_4 and C_5, C_6 and C_9 were found to be on par with each other, the combinations C_9, C_8 and C_{10} were observed to be inferior to the other combinations.

Colour is one of the most important characteristics by which quality of food is judged. Combinations C_5 and C_6 scores higher mean values for colour. The reason may be due to be the presence of maida in the combination. The inclusion of soy gave the combinations a brown colour and an increase in percentage of soy resulted in a subsequent increase in browness. C_1 and C_{10} rated poorly for colour.

According to Vandana *et al.* (1999) flavour is one of the most important sensory properties and is used by consumers for judging both

quality and variety of food products. A significant difference in the mean score of flavour of the various combinations could be observed. The flavour of C_2, C_3, C_4, C_5 and C_9 were rated better than others. The flavour of C_1 was least favoured.

Texture is the physical property of food stuffs apprehended by the eye, skin and muscle sense located in the mouth. Since flour was prepared by milling soy grits it gave a soft to fibrous texture to the combinations depending on the extent to which soy flour was added. Highest mean score was recorded for C_5 (soy 60, maida 25 and milk powder 15) followed by C_4 and C_3. Rest of combinations were rated poorly.

Taste is the sensory response to soluble materials of the mouth. It is an important parameters for the acceptance of a food material. The highest mean score for taste was obtained by C_3 (soy 50, malted wheat 40 and milk powder 10) followed by C_6 and C_9.

The assessment of the organoleptic qualities of the combinations revealed that C_3 (soy, malted wheat and milk powder in the ratio 5:4:1) obtained highest mean scores for all the parameters except colour and texture.

Cost analysis is also an important criterion for the selection of the best combination. Sihna et al (1993) has recommended soy flour as an ideal substitute for expensive ingredients. The use of skimmed milk

powder was limited to 10 to 20 per cent so as to keep the price low without compromising on the nutritional quality. The combination C_3 obtained the lowest cost of Rs. 2.35/100g. Increase in cost was recorded for combinations with higher percentage of milk powder.

It was observed that no particular combinations secured highest scores for all parameters viz., nutritional adequacy, organoleptic qualities and cost. C_3 obtained good scores in most of the parameters and more over it obtained the lowest cost percentage. Hence C_3 which contained soy, malted wheat and milk powder in the proportion 5:4:1, was selected for the development of the energy food.

To a portion of the above mixture, sugar was added as described in Materials and Methods. The primary function of sugar in the contribution of a sweet flavour and taste. It also promotes tenderness, browning of surface of baked product. Sugar which is a simple carbohydrate supply important dietary energy especially useful to athletes and also contributes to glycogen storage (Williams, 1994).

The developed energy food was subjected to quality test specified by the ISI. Governmental agencies such as the Bureau of Indian Standards impose certain regulations to ensure marketing of good quality products. According to Govindan (1993) implementation of quality system standard for food products would result in several benefits. Through total efforts for improvement and sustenance of quality cost benefit could be achieved

which would give consumer satisfaction and better image for the products.

The characteristic features of the energy food was compared with that of the ISI. The results revealed that the energy food formulated was comparable to ISI specifications for the various parameters such as protein, fat, calories, ash and crude fibre content except moisture.

The moisture content of the energy food (5.2) was found to be slightly higher than that specified by ISI. This may be due to presence of soy in the combination. Higher moisture content for soy incorporated products was recorded by Beatrice *et al.* (1998).

The total protein (31.4g) and calorie content (406 kcal) were estimated and was much higher that specified by ISI. A combination of soy, wheat flour, skimmed milk powder and sugar accounted for the increase in protein and energy content of the energy food. Similar results were obtained by Litty and Chellammal (1997) and Rosita (1997). A high calorie content is beneficial since it easily meets the requirements of an energy food for athletes.

A fat content of 13 g was observed for the formulated food. Fat is a potential source of energy and also enhances taste ISI has not given any specification on fat.

Acid insoluble ash which gives information regarding the inorganic salts present in the product was found to be within the limits of that

specified by the ISI (0.08).

The crude fibre content of the energy food was also less than the maximum specified by the ISI.

Standardisation and selection of the best recipe

Standardisation of recipes is an essential strive for high quality products (Crusius, 1984) Haridas Rao (1993) has stated that the popularity of the baked products is due to their ready to eat convenient nature, unique taste and ready availability at reasonable cost. Baked products have been effectively used as supplementary food by several workers. Sindhu and Prema (1995) incorporated bread as a supplementary food for pre school children. Walter *et al.* (1993) used iron fortified cookies as an effective supplement for school going children. And hence it was decided to develop biscuits from the formulated energy food as a supplementary food for the athletes.

In the present study ten types of biscuits based on the energy food were standardised in the laboratory.Attempt was also made to test the acceptability of the biscuits through organoleptic evaluation and preference test.

The organoleptic qualities of the standardised biscuits were assessed as explained in Materials and Methods. The biscuits were scored for appearance, colour, flavour, texture, doneness and taste.

Butter biscuit recorded the highest mean score for appearance followed by chocolate biscuit. The lowest mean score was recorded for sweet and salty biscuit. This may be due to the uneven browning of the bisciut.

Colour is associated with every aspect of our life and influences. According to the reports from CFTRI (1990), the aesthetic, sensory characteristics and acceptability of food are all affected by colour. The colour of coconut biscuit and dates biscuit were most preferred. It was observed that chocholate and jam biscuit secured low scores. This may be due to the dark brown colour of cocoa and also dark shade due to the addition of jam. The addition of chocholate or cocoa brings a dark colour to all products and this is in no way a negative characteristic.

Flavour is an important parameter for organoleptic studies. The highest mean score for flavour was obtained by chocholate biscuit and butter biscuit. The flavour of butter and chocolate may be responsible for its high mean values.

According to Rolls *et al.* (1981) in the various quality attribute tests, the first preference goes to the taste followed by appearance, texture and colour. The highest mean score for taste was obtained for butter biscuit followed by chocholate biscuit. The lowest score was obtained for sweet and salty biscuit. This may be due to excess of salt in the biscuit.

Doneness was ascertained by pressing the crumb with fingers to see whether sticky or not. Doneness contribute a major factor in the final acceptance of the biscuit. There was no significant difference between the biscuits as far as doneness is concerned. All the biscuit got high mean scores. Butter and chocolate biscuits secured the highest mean scores.

Texture is a perception resulting from interaction between food and its consumer (Jack *et al.*, 1995). It constitutes a physical property of food stuffs apprehended by the eye, the skin and muscle sense located in the mouth. Among the different types of biscuit, chocolate biscuit secured the highest mean scores regarding texture. There was no significant difference regarding texture of the biscuits.

Indian Food Industry (1995) reports that the quality is the main criterion on which the acceptability of any product depends. Over all acceptability depends on the concentration or amount of particular components. The nutritional and other hidden attributes of a food and its palatability or sensory quality. Among the biscuits butter biscuit was most acceptable. Chocolate biscuit was the second most preferred. Coconut biscuit, cardamom biscuit and jam biscuit scored good scores and sweet and salty biscuit attained low scores.

Preference tests are designated to determine consumer's subjective reactions to external phenomena and their reasons for having

them. While conducting preference tests, the consumer expects to be favourably impressed with the food he tastes and expresses displeasure if the product does not measure upto his anticipations.

According to Watts *et al.* (1989) development of new food products or the reformulation of existing products can be attained either by introducing different processing methods, or by use of new ingredient and the acceptability of this could be assessed by conducting preference tests on a large number of consumers. In the present study preference tests for the developed recipes were conducted among athletes and sports personnel.

Preference score rating among athletes revealed that among the ten recipes, the most preferred was butter biscuit (46 per cent). This may be due to use of butter which gave a better flavour than vanaspati which was used in all the other types of biscuits. Chocolate biscuit (44 per cent) was second most preferred biscuit. Most of the biscuits were well accepted by the athletes except sweet and salty biscuits. Negative score for these biscuits may be due to lack of flavour in the biscuit.

Preference score among sports personnel also revealed a similar trend. Butter biscuit (60 per cent), chocolate biscuit (56 per cent) and salty Jam biscuit (56 per cent) were highly preferred. Sweet and salty biscuit was the negatively rated biscuit. Flavoured biscuits were more popular than plain biscuit among both athletes and sports personnel.

Selection of most acceptable biscuit for the conduct of the feeding trial was based the organoleptic and preference tests. The results of the two tests reveal that both butter and chocolate biscuits were most preferred. But since cost of production of chocolate biscuit which was made with vegetable oil is cheaper than butter, chocolate biscuit was selected for the supplementary feeding trials for athletes.

The selected biscuit was subjected to quality tests specified by Bureau of Indian standards (BIS). The results of the tests reveals that the product met all the specifications of BIS except in ash content and fat.

The protein content of the biscuit (33.02 g) was much higher than that specified by ISI. Use of defatted soyflour, milk powder and malted wheat may be reason for this.

Moisture content of the biscuit was within limits specified. Lower moisture content of the product is beneficial since it may improve the shelf life of the product.

The use of defatted soyflour may be reason for the lower fat content of the biscuit than that specified by ISI.

The acid soluble ash in the biscuit was found to be slightly higher than that specified by ISI. The increased mineral content of soyflour

may be the reason for this. Increased mineral content in defatted soy incorporated blend with wheat was found in studies by Chauhan and Santhosh, (1990).

The crude fibre content of the biscuit was well within limits specified by ISI (3.0).

According to Potty (1993) the nutritive value of a food is an important parameter for the development of any new food. The selected biscuit was analysed for its energy and protein content. According to Amla (1993) when new food products are developed, the nutritive value may get lost because of the inappropriate processing methods. To ascertain the nutritional loss during processing the energy and protein value of the biscuit was also determined before processing.

Energy is essential for rest, activity, growth and maintenance of good health. According to energy requirement are increased considerably during athletic activities. The estimated energy content of the biscuit was 639kcal while the value before cooking was 640 kcal per 100g. This variation may be due to loss during processing. A similar loss in the calorie content was observed by Binila (1998).

Protein is one of the most important nutrient required by the body to carry out a wide range of functions essential for body building and the maintenance of life. According to Clara (1986) maintenance of muscle

— in athletes requires adequate intake of proteins. There was a slight loss in protein content in the biscuit after baking. This finding is in line with the results obtained by Chellammal and Prema (1995).

Determining the impact of the product among athletes through feeding trials

Feeding trials constitute an essential part of any study to determine the impact of certain foods on the health and function of the experimental group. Ritchy and Taper (1981) and Swaminathan emphasized this fact through experiments on animals or human beings. The diets consumed by a large majority of young athletes in India is deficient in most nutrients. A study conducted by Mini (1992) at a local sports school in Kerala revealed that the diets consumed by them lacked in most nutrients especially calories and protein. Diet low in essential nutrients have a deleterious effect on the nutritional status of an athlete and this reduces his work efficiency and performance.

The target group for the assessment of the impact of the energy food were adolescent girl athletes. Rao(1990) ascertained that the physical and physiological changes impose great demand on the nutritional requirement during adolescence and their nutritional requirements are much greater than any other group. Moreover this demand is doubled when the adolescents are engaged in sports activities.

The nutritional status and efficiency status of the athletes were assessed before and after the completion of the feeding trial.

Assessing the nutritional status

Diet is a vital determinant of health and nutritional status of a individual. In assessing the nutritional status, it is necessary to elucidate the relationship of nutrient intake with deficiency as well as nutrient gaps and excesses (Thinmayamma and Parvathy Rao, 1998). The nutritional status was assessed with respect to anthropometric measurements, clinal status and biochemical estimations.

Anthropometric measurements

The height of an individual is influenced both by genetic and environmental factors. Maximum growth potential of an individual is decided by hereditary factors while nutrition determined the extent of exploitation of that genetic potential.

The average height of the athletes did show an increase even though the increase was not statistically significant. Height is a parameter which does not reveal a significant difference in a period of six months. A similar result was reported by Litty and Chellammal (1998).

Body weight is an important factor that influences a person's capacity to do work (Bhargava, 1999). Body weight is the most widely used and simplest reproducible anthropometric measurement, for the

evaluation of nutritional status (Gopaldas and Sheshadri, 1987).

A significant increase in weight of the athletes is recorded after the completion of the experiment. An average increase of 2.10 kg was recorded. The reason for this increase may be due to the high energy protein and fat content in the food. A similar increase in weight was recorded by a study conducted by Sailaxmi (1995) and Litty and Chellammal (1998).

Chest and arm circumferences are useful parameters for determining the nutritional status of the individual. According to Beegum, (1991) arm circumference gives an assessment of muscle mass, subcutaneous tissue and hence indirectly the nutritional status. This is an important factor for young athletes.

There was no statistically significant difference in the chest circumference of the athletes even though a net mean increase(0.2cm) could be recorded.

Standards prepared by NNMB (1996) for adolescent girls from Kerala was used in the present study for comparison to with the observed average height , weight and arm circumferance. Since there is no standard for chest circumference the data generated was not included.

Height for age profile shows the state of chronic malnutrition (Gopal

Das and Sheshadri ,1987). The extent of height deficit in relation to age, as compared to standard can be regarded as a measure of the past dietary history of the subject. In the study the observed mean height of the athletes in the age group of 11, 12 and 13 years, was found to be significantly higher than the standard. A similar result was also obtained for the mean weight and arm circumferance of the athletes as compared with the standard of adolescent girls in Kerala. Weight for age is an index effectively used to determine the current state of nutritional status of children.

Body Mass Index (BMI) is regarded as a good indicator of the nutritional status of children (NIN ,1991).The BMI of the athletes showed significant improvement after the completion of the feeding trial. According to BMI index suggested by James et al (1988). BMI less than 18.5 indicate under nutrition. As revealed in the data, athletes suffering from under nutrition was 68 per cent initially which was reduced to 42. 8 % after the completion of the feeding. Increase in percentage of athletes with normal BMI from 31 - 57 per cent is a measure of improvement after the incorporation of the enegy food.

Clinical profile

Clinical examination is the most essential part of all nutrition surveys since the ultimate objective is to assess levels of health of individuals as influenced by the diet they consume (Swaminathan, 1985).

The clinical profile of the athletes revealed that they were free from most of the deficiency diseases. A high percentage (34 per cent) of athletes were suffering from knock knees. This condition is the deformity of the bone structure and correction possibilities are limited. The number of cases with symptoms of anaemia (34.4 per cent) was greatly reduced after the completion of the feeding trial. Iron deficiency anaemia is most common in India and sports-women are most susceptible to this (Eastwood, 1997). This condition reduced the work efficiency of the athlete. Deficiency symptoms like tongue papillae and molted teeth and lymph enlarged were absent at the final assessment. Thyroid enlargement cases remained the same. The reason may be because it is a symptom of a more serious ailment and recovery is not based on diet alone.

Biochemical estimations

Biochemical tests are powerful tools not only for assessing nutritional status but also for deriving estimation of nutrient requirement. Biochemical changes in any deficiency disease occur prior to clinical manifestations. Hence biochemical tests conducted, help to determine disease at a sub-clinical stage. According to Bamji (1997) biochemical or subclinical deficiency may have some subtle functional deficiencies such as decreased work capacity and psychomotor performance, faulty host defence mechanism and impaired wound healing. These symptoms can seriously impair performance of an athlete.

Biochemical tests such as haemoglobin and serum protein content in the blood of athletes were estimated. There was a significant difference in the initial and final values of these two parameters.

Haemoglobin content of the blood determines the oxygen carrying capacity of the blood. The fitness and physical endurance of the individual is related to the oxygen carrying capacity of the blood. Low levels of circulating haemoglobin (<11g/dl) due to anaemia, can compromise the maximal work capacity, due to reduced oxygen carrying capacity of the blood. Rao (1996) has upheld the above observation. The haemoglobin profile of the athletes after the completion of the feeding revealed a significant increase(0.18g/dl) in the haemoglobin levels of the blood.

Serum protein levels also showed significant increase. The high protein content (33g / 100 g) of the test food may be responsible for the increase in serum level. According to Swaminathan (1985), during intense physical activity muscle protein break down increases the amino acid in circulating blood. Hence the level of serum protein level increases.

Work efficiency and performance tests

According to the Exercise Physiology lab manual (1984), work efficiency tests are used to measure the physical endurance and fitness level of sports persons .The working capacity of individuals such as sports persons undergoing strenuous physical activiy is severly affected due to consumption of inadequate intake of extra energy, proteins and

vitamins.The parameters used to measure the work efficiency and performance of the athletes were aerobic ,anaerobic and strength test.

Aerobic test

The aerobic capacity of the athletes were measured using Sharkey's Forestry Step Test (1977). The primary purpose of the test was to measure the aerobic (cardiovascular endurance) fitness of persons. The physiological rationale of the forestry step tests focuses upon the relationship between oxygen consumption and exercise.

It can be revealed from Table 22 that, as the volume of oxygen consumed (VO_2 max.) increased, the pulse rate decreased. According to Kawatra (1999) low availability of oxygen to the tissues affecting the cardiac output and hence lowers work efficiency. The interpretation of the predicted maximal oxygen consumption from the step test is made by consulting the aerobic fitness norms prepared by the investigation from Age adjusted aerobic Fitness Chart (Sharkey, 1984). The increase in VO2 max. led to the subseqent increase in the fitness level of the athletes. At the same time the pulse rate of the athletes decreased and there was an increase in the intake of oxygen. According to Sathyanarayana,(1988) under nourished individuals show higher heart rate indicating that cardeo vascular endurance is below par.

It can be concluded that the level of fitness significantly increased after the incorporation of the test food. Since one of the athletes was unfit to undertake the experiment, average oxygen consumption was found from 34 athletes.

Anaerobic test

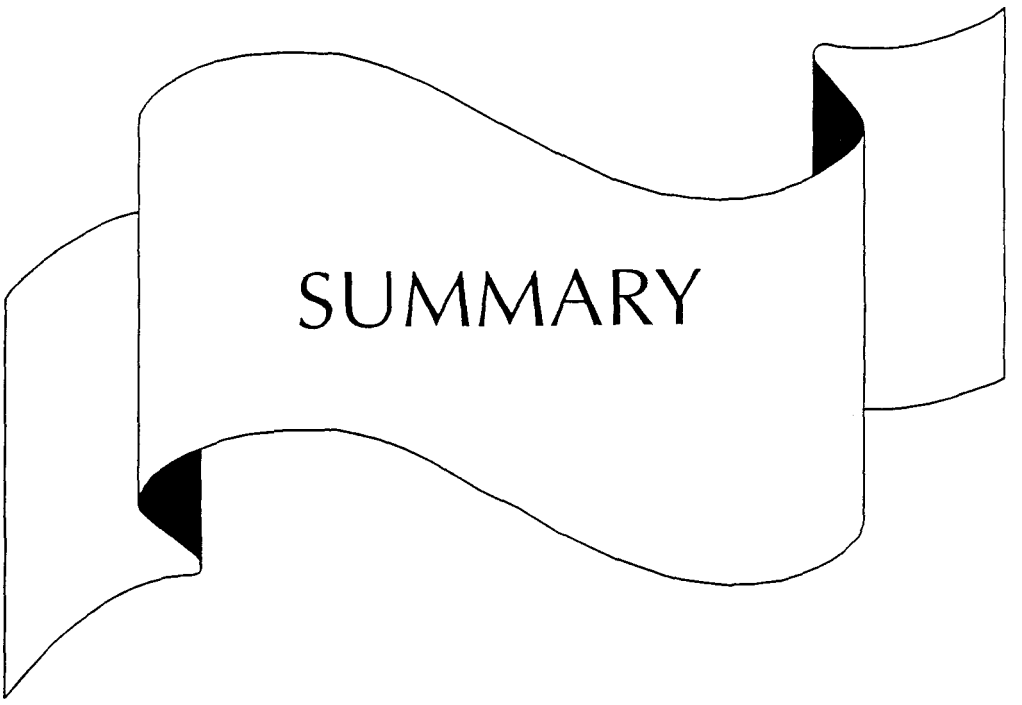
The anaerobic capacity of the athletes was measured using Sergeant Jump Test. The test is considered a short component of anaerobic fitness. In this test the jumping ability is dependent biochemically not on oxygen but on the individual phosphagen capacity and the ability to use these phosphagen stores at a rapid rate. The skill and agility is put to test.

In the present study the aerobic power ($kgm.s^{-}$) of the athletes was derived from D values and weight of individual athletes. A significant difference in the aerobic power is recorded. Final meal aerobic power of the athletes was 54. According to Adams (1992) an aerobic power of 75 $kgm.s^{-1}$ was recorded for senior (18-19 year) physical education students in United States.

Strength test

The srength tests were used to measure the positive work capacity and power as influanced by the strength of the athletes.The two tests used to measure the strength of the athletes were Bench press test and Over head test.

The interpretation of the strength scores (1 RM) based upon the body weight of the athletes indicate a significant increase in the final 1-RM values of both the tests.Hence it can be concluded that the strength of the athletes improved significantly.


SUMMARY

SUMMARY

The present study on the "Impact of soy based energy food on the nutritional status and performance of adolescent athletes", was undertaken for which soy grits was used as the basic ingredient along with milk powder. Other ingredients tried along with them were malted wheat, maida, cassava, rice and sweet potato flours. Ten combinations were tried with these ingredients.

The principle governing the selection of the best combination were nutritional adequacy, overall acceptability and cost. The nutritional adequacy was assessed by computing the calorie and protein content and chemical score. The acceptability of the combinations were assessed through organoleptic evaluation with a panel of ten selected judges. Cost of different combinations were computed as per the market price. The combination which got high scores in all parameters was selected for the development of the energy food, which included soy, malted wheat and milk powder in the proportion 5:4:1.

The proposed energy food was developed using the selected combination and later blended with sugar to increase palatability and calorific value. Accordingly 1 kg of the food was prepared every week.

Type tests specified by ISI were administered to the energy food for confirmation of quality. The energy food contained 409 kcal and 31.49 per 100g of protein.

The energy food was used for the development of biscuits. Ten types of biscuits were standardised in the laboratory namely plain, butter, chocholate, ginger, sweet and salty, dates, jam and melt-in-mouth biscuit.

Selection of the most preferable biscuit for the conduct of feeding trial was based on the organoleptic and preference tests and also cost of the developed biscuits. The organoleptic qualities of the ten types of biscuits were assessed by the panel of judges already selected. Preference tests for the recipes was conducted among athletes and sports personnels.

The results of the test revealed that both butter and chocholate biscuit were rated highly. When compared to butter biscuit cost of production of chocholate biscuit was less. Hence it was selected for the conduct of the feeding trial.

Type test specified by ISI were administered to the biscuit for for confirmation of quality. Chocholate biscuit contained 5.5 per cent moisture, 12 per cent fat, 1.0 per cent acid insoluble ash and 2 per cent crude fibre. The biscuit was found to have a calorie content of 639 kcal and protein content of 33 per 100 g.

The impact of the food was assessed through feeding trial. Feeding was conducted on thirty five adolescent athletes residing at the government sports hostel for scheduled castes and tribes of Jagathy. Nutritional status and performance tests were the criteria based on which the impact was assessed. The nutritional status of the athletes was ascertained with reference to their anthrometric measurements (Height, weight, arm and chest circumference), clinical profile and biochemical estimations.

Regarding anthropometric measurements a significant difference in the weight and arm circumference of the athletes was recorded after the completion of feeding trial. An average increase of 2 kg in the weight and 1.38 cm in the arm circumference was recorded. A change in the clinical profile of the athletes was also noticed. Athletes suffering from deficiency symptoms were reduced from 83 to 60 per cent. Biochemical estimations also recorded a significant increase in the Haemoglobic content (0.18) and serum protein (0.15) levels of athletes.

The impact of the food on the performance of the athletes was assessed through Aerobic test (Sargent Jump Test), Anerobic test (Step test) and strength test (Bench press and Overhead press). A significant difference in the initial and final values of the above tests were observed.

The energy food thus developed in the form of biscuits, apart from offering good taste is an item with substantial energy giving properties having wholesome and nutritive quality at affordable prices. More over

it is easily available and has a good shelf life. They could be suitably incorporated into the dietaries of atheletes especially for the younger age group and can be popularized as an effective supplement for them.

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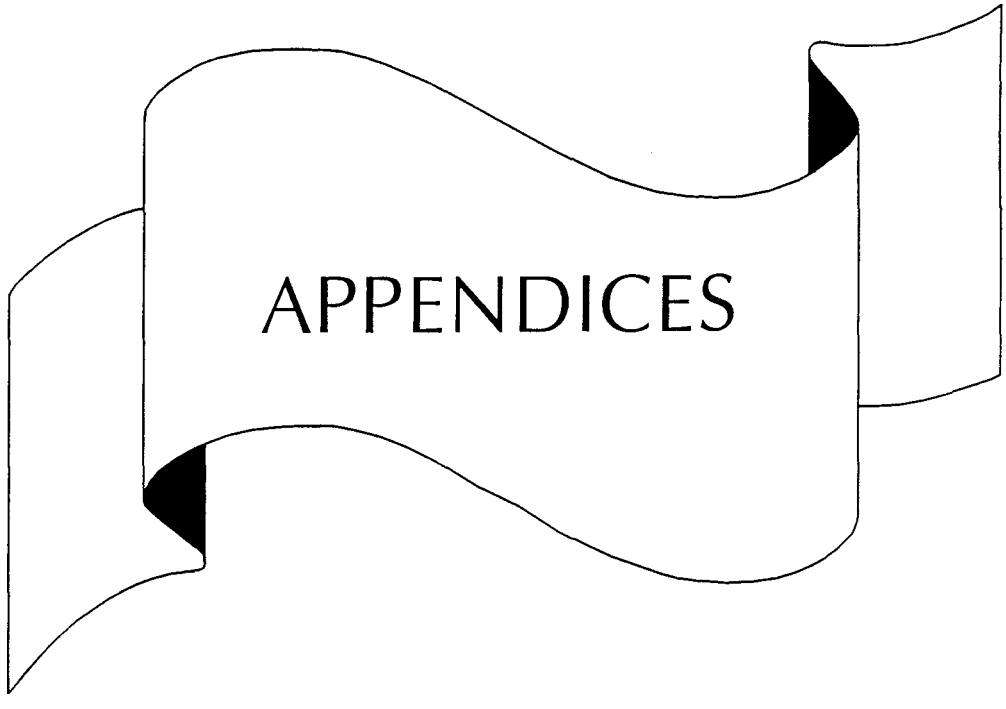
APPENDICES

Appendix -1

CHEMICAL SCORE OF DIFFERENT COMBINATIONS OF THE ENERGY FOOD

Ingredients	Amount	Arginine	Hystidine	Lysine	Tryptophan	Phenylalanine	Tyrosine	Methionine	Cystein	Threonine	Leusine	Isoleucine	Valine
Soy	60	290	90	240	48	180	26	48	60	144	288	192	192
Malted wheat	25	115	40	95	17.5	57.5	47.5	27.5	25	65	102.5	60	75
Milk powder	15	33	27	73.5	13.5	46.5	45	25.5	7.5	42	94.5	54	63
Total	—	438	157	408.5	79	282.5	218.5	101	92.5	251	485	306	330
Chemical score - 87.7													
Soy	55	247	82.5	220	44	165	115.5	44	55	132	264	176	176
Malted wheat	30	138	48	114	21	69	57	33	30	78	123	72	90
Milk powder	15	33	27	73.5	13.5	46.5	45	25.5	7.5	42	94.5	54	63
Total	—	415	157.5	407.5	78.5	280.5	217.5	102.5	92.5	252	481.5	302	329
Chemical score - 87.2													

(Appendix 1. Contd...)

Ingredients	Amount	Arginine	Hystidine	Lysine	Tryptophan	Phenylalanine	Tyrosine	Methionine	Cystein	Threonine	Leusine	Isoleucine	Valine
Soy	50	225	75	200	40	150	105	40	50	120	240	160	160
Malted wheat	40	184	64	152	28	92	76	44	40	104	164	96	120
Milk powder	10	22	18	49	9	31	30	17	5	28	63	36	42
Total	—	431	157	401	77	273	211	101	95	252	467	292	332
Chemical score - 85.2													
Soy	45	202.5	67.5	180	36	135	94.5	36	45	108	216	144	144
Malted wheat	40	184	64	152	28	92	76	44	40	104	164	96	120
Milk powder	15	33	27	73.5	13.5	46.5	45	25.5	7.5	42	94.5	54	63
Total	419.5	158.5	405.5	77.5	273.5	215.5	105.5	92.5	314	474.5	294	327	
Chemical score - 86.1													

(Appendix 1. Contd...)

Ingredients	Amount	Arginine	Hystidine	Lysine	Tryptophan	Phenylalanine	Tyrosine	Methionine	Cystein	Threonine	Leusine	Isoleucine	Valine
Soy	55	247	82.5	220	44	165	115.5	44	55	132	264	176	176
Maida	30	57	36	33	18	87	39	27	42	45	120	66	72
Milk powder	15	33	27	73.5	13.5	46.5	45	25.5	7.5	42	94.5	54	63
Total	—	337	145.5	326.5	75.5	298.5	199.5	96.5	104.5	219	478.5	296	311
Chemical score - 85.0													
Soy	60	270	90	240	48	180	126	48	60	144	288	192	192
Maida	25	47.5	30	27.5	15	72.5	32.5	22.5	35	37.5	100	55	60
Milk powder	15	33	27	73.5	13.5	46.5	45	25.5	7.5	42	94.5	54	63
Total	—	350.5	147	341	76.5	299	203.5	96	102.5	223.5	482.5	301	305
Chemical score - 83.5													

(Appendix 1. Contd...)

Ingredients	Amount	Arginine	Hystidine	Lysine	Tryptophan	Phenylalanine	Tyrosine	Methionine	Cystein	Threonine	Leusine	Isoleucine	Valine
Soy	50	225	75	200	40	150	105	40	50	120	240	160	160
Cassava	30	174	33	22.9	24	54	30	15	27	60	90	75	92
Milk powder	20	4	36	98.5	18	62	60	34	10	56	126	72	84
Total	—	443	144	321.4	82	266	195	89	87	236	456	307	336
Chemical score - 90.5													
Soy	55	247	82.5	220	44	165	115.5	44	55	132	264	76	176
Cassava	30	174	33	32.9	24	54	30	15	27	60	90	75	72
Milk powder	15	33	27	73.5	13.5	46.5	45	25.5	7.5	42	94.5	54	63
Total	—	454	142.5	326.4	81.5	265.5	190.5	84.5	89.5	234	448.5	305	311
Chemical score - 91.5													

(Appendix 1. Contd...)

Ingredients	Amount	Arginine	Hystidine	Lysine	Tryptophan	Phenylalanine	Tyrosine	Methionine	Cystein	Threonine	Leusine	Isoleucine	Valine
Soy	50	225	75	200	40	150	105	40	50	120	240	160	160
Rice	35	168	45.5	80.5	28	98	101.5	52.5	31.5	80.5	175	107	133
Milk powder	15	33	27	73.5	13.5	46.5	45	25.5	7.5	42	94.5	54	63
Total	—	426	147.5	354	81.5	294.5	251.5	118	89	242.5	509.5	321	356
Chemical score - 90.5													
Soy	55	247	82.5	220	44	165	115.5	44	55	132	264	176	176
Sweet potato	30	84	27	78	33	81	45	30	9	84	108	87	114
Milk powder	15	33	27	73.5	13.5	46.5	45	25.5	7.5	42	94.5	54	63
Total	—	364	136.5	371.5	90.5	292.5	205.5	99.5	71.5	258	466.5	317	353
Chemical score - 51.0													

Appendix - 2

SCORE CARD FOR ASSESSING ORGANOLEPTIC QUALITIES OF COMBINATIONS

Appearance

Excellent	5
Good	4
Satisfactory	3
Mediocre	2
Poor	1

Colour

White	5
Cream	4
Pale yellow	3
Yellow	2
Dark yellow	1

Flavour

Excellent	5
Good	4
Satisfactory	3
Mediocre	2
Poor	1

Texture

Smooth	5
Soft	4
Fibrous	3
Hard	2
Tough	1

Taste

Excellent	5
Good	4
Satisfactory	3
Mediocre	2
Poor	1

Appendix - 3

SCORE CARD FOR ASSESSING THE ORGANOLEPTIC QUALITIES OF BISCUIT

Quality	Grade	Description	Scores
Appearance			
	Excellent		5
	Good		4
	Fair		3
	Poor		2
	Very poor		1
Flavour			
	Highly acceptable		5
	More acceptable		4
	Acceptable to certain extent		3
	Less acceptable		2
	Not acceptable		1
Colour			
	Brownish white		5
	Yellowish white		4
	Dull white		3
	Brown		2
	Dark brown		1
Taste			
	Excellent		5
	Good		4
	Fair		3
	Poor		2
	Very poor		1
Donneness			
	Well cooked		5
	Moderately cooked		4
	Partially cooked		3
	Moderately uncooked		2
	Uncooked		1

Quality	Grade	Description	Scores
Texture			
Crisp			5
Coarse			4
Sticky			3
Hard			2
Very hard			1
Overall acceptability			
Like extremely			5
Like very much			4
Like moderately			3
Dislike slightly			2
Dislike extremely			1

Appendix - 4

RECIPES FOR BISCUITS

1. PLAIN BISCUIT

Ingredient

*Flour	-	150 g
Vanaspati	-	50 g
Caster sugar	-	100 g
Vanilla essence	-	½ tsp
Salt	-	a pinch
Baking powder	-	½ tsp

Method

Cream fat and sugar till light and fluffy. Mix in maida and essence and knead into a stiff dough. Spread the dough into ¼ inch thickness and cut into shape as desired. Place on a greased tray and bake at 110°C till done.

2. BUTTER BISCUIT

Ingredients

*Flour	-	150 g
Caster sugar	-	100 g
Butter	-	60 g
Baking powder	-	½ tsp
Water	-	to make dough
Salt	-	a pinch

Method

Cream butter and sugar till light and fluffy. Sieve together flour, baking powder and salt, add to the creamed butter and sugar. Knead well to make a stiff dough. Add water or milk if required. The dough is rolled out into a 1/4th inch thickness and cut into shape. Place on a greased tray and bake till golden brown. Remove from tray and cool.

3. CHOCHOLATE BISCUIT

Ingredients

*Flour	-	500 g
Caster sugar	-	400 g
Cocoa	-	15 g
Vanaspati	-	300 g
Baking powder	-	5 g
Milk / water	-	to make dough

Method

Lighten fat and caster sugar, sieve together flour, cocoa and baking powder, add to the fat and sugar. Add milk or water and knead. The dough is rolled out into a ¼ inch thick sheet and cut into shape with a biscuit cutter. Place on a greased baking tray and bake at 110°C for 10 minutes or till done. Remove from tray and cool completely.

4. COCONUT BISCUIT

Ingredients

*Flour	-	220 g
Ground sugar	-	200 g
Desiccated coconut powder	-	1½ cup
Vanaspati	-	100 g
Baking powder	-	½ tsp.
Milk / water for kneading		
Dry grated coconut	-	a little

Method

Sieve flour and baking powder together. Cream fat and sugar, add to it coconut powder and mix well. Fold in the flour to the sugar and coconut mixture and knead into a stiff dough with milk or water. Roll out the dough into ¼ cm thick sheet and cut into desired shape. Prick them with fork and put a little dry grated coconut on it. Place them in a greased tray and bake at 110°C for 10 minutes or till done.

5. GINGER BISCUIT

Ingredients

*Flour	-	500 g
Sugar	-	400 g
Vanaspati	-	300 g
Salt	-	5 g
Baking powder	-	5 g
Dry ginger powder	-	15 g
Milk / water	-	to make dough

Method

Sieve flour, ginger powder and baking powder twice. Cream fat and sugar till light and fluffy. Add salt, flour and mixed well. Roll out the dough to ¼ inch thickness and cut into shape as desired with a biscuit cutter. Place on a greased baking tray. Pierce with the fork and bake in a moderate oven till golden brown.

6. SWEET AND SALTY BISCUIT

Ingredients

*Flour	-	250 g
Vanaspati	-	125 g
Ground sugar	-	50 g
Sodium bicarbonate	-	7.5 g
Salt	-	7 g
Milk / water for kneading		
Cumin seeds	-	a little

Method

Cream vanaspati and sugar till light. Add salt and sodium bicarbonate and cream again. Add milk gradually. Add the cumin seeds and flour and make a hard dough. Roll out the dough into ¼ inch thick sheet and shape as desired using a biscuit cutter. Place in a greased tray and bake till golden brown.

9. JAM BISCUITS

Ingredients

*Flour	-	220 g
Ground sugar	-	200 g
Vanaspati	-	100 g
Baking powder	-	½ tsp.
Mixed fruit jam	-	1/2 cup
Milk / water	-	for kneading

Method

Sieve flour and baking powder together. Mix sugar, vanaspati and half of the jam together. Add to sugar mixture and knead to a stiff dough. Roll out the dough into ½ inch thick sheet and cut into desired shape. Prick them with fork. Bake till done. Cool and put a little jam over the biscuits before serving.

10. MELT-IN-MOUTH BISCUIT

Ingredients

*Flour	-	250 g
Baking powder	-	5 g
Egg	-	1
juice of two lemon		
Dalda	-	140 g
Caster sugar	-	140 g
Crushed corn flakes or bread crumbs	-	as required

Method

Sieve the flour with baking powder. Cream the fat with sugar separately. Beat the egg, add lime juice and beat in the egg to the creamed butter and sugar. Add flour and mix thoroughly. Roll out into floured board to ½ inch thickness. Cut into desired shape and dip into powdered corn flakes or bread crumbs. Place on a greased tray and bake till golden brown.

* - Flour - soy, malted wheat and skimmed milk powder in the proportion 5 : 4 : 1

Appendix - 5

PROCEDURE TO CONDUCT AEROBIC STEP TEST

Purpose

To measure aerobic capacity

Procedure

The subject was asked to stand facing the 40 cm step bench. On the command 'ready start', the subject started stepping and the timer was started. The acadence required was given as follows 'Up-one', one foot goes to top of step. 'Up-two', the other foot follows to top of step. 'Down-one', one foot descends to floor. 'Down-two', the other foot follows to the floor. The subject lending foot may be changed a few times during the test. The subject is instructed to extend the knees fully when both feet are over the step. The stepping continues for five minutes, unless the subject requests to sit down. After 15 seconds, the pulse is counted for 15 seconds and is recorded.

Scoring

The aerobic capacity is calculated from the norms corresponding to subjects weight and 15 second pulse count.

Appendix - 6

AEROBIC FITNESS CATEGORIES IN MEN (M) AND WOMEN (W) FOR THE FORESTRY STEP TEST

Age (y)		Fitness category						
		Superior	Excellent	Very good	Good	Fair	Poor	Very poor
		Maximal oxygen consumption ($ML.kg^{-1}. min^{-1}$)						
10	M	58 +	57 - 53	52 - 48	47 - 43	42 - 38	37 - 33	< 33
	W	55 +	54 - 50	49 - 45	44 - 40	39 - 35	34 - 30	< 30
15	M	57 +	56 - 52	51 - 47	46 - 42	41 - 37	36 - 32	< 32
	W	54 +	53 - 49	48 - 44	43 - 39	38 - 34	33 - 29	< 29
20	M	56 +	55 - 51	50 - 46	45 - 41	40 - 36	35 - 31	< 31
	W	53 +	52 - 48	47 - 43	42 - 38	37 - 33	32 - 28	< 28

Appendix - 7

PROCEDURE TO CONDUCT SERGENT JUMP TEST

Purpose

To measure anaerobic power (P)

Procedure

The subject stands with dominant side against the wall holding the feet together. The subject reaches as high as possible without raising the heel and puts a mark on the wall with the wet middle finger of the dominant arm. The highest point is observed and is recorded in cm. Now, the subject gets ready to jump without any preparatory movement except one dip of the arms and knees. The subject jumps and puts a mark with the wet middle finger on the wall. This mark is also observed and recorded.

Scoring

The difference between standing reach and jumping reach is found and the anerobic power is derived from the equation $P = 2.21 \times wt \times \sqrt{D}$.

Appendix - 8

PROCEDURE TO CONDUCT STRENGTH TEST

Purpose

To measure one repetition maximal (1-RM)

Procedure

Bench press - The subject lies supine, resting the hip shoulder and the head on the bench and the feet on the floor, straddling the bench. Two spotters place the barbell in the hands of the subject, spaced about shoulder width apart and arms extended above chest. The barbell is loaded with weights with which he can do bench press repititions between 2-20.

Overhead press - The barbell is kept on the weight stand and was loaded with weights with which the subject can do repetition between 2-20. The subject goes beneath the barbell, place the barbell over his shoulder behind the neck. He holds the barbell shoulder width apart. The spotters assist the subject in raising the weight. The subject bends the knee to an angle of 90 degree and comes back, to an erect position. This is repeated for a maximum of repetitions between 2-20.

Scoring

The number of repetitions and the weight on the stand are recorded. The 1-RM is calculated from the formulae, 1-RM=kg at RM bet 2-20/[100% - (RM x 2)]

APPENDIX 9

HOSTEL DIET FOR THE ATHLETES

Braekfast	-	Idli / Dosa / Puttu / Sambar / Bengal gram curry
Lunch	-	Rice, Fish,/ Chicken curry / Beef curry Veg. thoran , Pickles.
Tea	-	Tea , Biscuits
Dinner	-	Chappathi / Rice , One veg. curry Butter milk.
Bed time	-	Milk

IMPACT OF SOY BASED ENERGY FOOD ON THE NUTRITIONAL STATUS AND PERFORMANCE OF ADOLESCENT ATHLETES

By

ROHINI NAIR

ABSTRACT OF THE THESIS
SUBMITTED IN PARTIAL FULFILMENT OF
THE REQUIREMENT FOR THE DEGREE OF
MASTER OF SCIENCE IN HOME SCIENCE
(FOOD SCIENCE AND NUTRITION)
FACULTY OF AGRICULTURE
KERALA AGRICULTURAL UNIVERSITY

DEPARTMENT OF HOME SCIENCE
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VELLAYANI, THIRUVANANTHAPURAM

1999

ABSTRACT

The present study on "The impact of soy based energy food on the nutritional status and performance of adolescent athletes", was initiated using soy grit as the basic ingredient. Other ingredients used were milk powder, malted wheat, maida, cassava, rice and sweet potato. The principles governing the selection of the best combination of ingredients were nutritional adequacy, overall acceptability and cost. The combination of soy, malted wheat and milk powder in the proportion of 5:4:1 which secured high scores for the development of energy food.

Type tests specified by the Bureau of Indian Standards administered to the food revealed that the product satisfied the 'BIS' specification for similar products. The energy and protein content was even higher than specified.

Ten types of biscuits such as plain, butter, chocholate, ginger, sweet-salty, dates, jam and melt-in-mouth biscuits were standardised in the laboratory using the formulated energy food.

The most preferred biscuit for the conduct of the feeding trial was selected based on the organoleptic tests, Preference of the

consumers and cost. The tests revealed that both butter and chocholate biscuits were preferred by most of the consumers. Chocholate biscuit was selected with regard to its lower cost of production when compared to butter biscuit. The quality parameters of the biscuit were comparable with 'BIS' specification.

The impact of the food on the nutritional status and performance was assessed on adolescent athletes (girls). Athletes from a local sports hostel in the age group of 11 to 14 years were selected for this purpose.

The nutritional status of the athletes assessed through anthropometric measurements (height, weight, arm and chest circumference), clinical profile and biochemical estimation recorded a significant improvement with special reference to weight, arm circumference, haemoglobin and serum protein levels of the athletes.

The performance of the athletes after the incorporation of the energy food was assessed using aerobic, anaerobic and strength tests. A significant improvement in all the above tests were recorded.

The above observations and findings of the study revealed that the developed energy food in the form of biscuits can be effectively used as a supplement for improving the health and thereby enhancing the performance of athletes especially young athletes.