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Original Research Article

Development and Nutritional Evaluation of Food Formulation for Overweight Home Makers

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A B S T R A C T

A study was conducted to standardize low calorie food formulation for overweight homemakers and to evaluate its functional properties and chemical composition. Ingredients from food groups like cereals, millets, pulses, fruits and vegetables and nuts were selected for the development of the formulation. Developed formulation was analyzed for functional properties and chemical composition using standard procedures. Functional properties of low calorie food formulation per 100 gram for water absorption capacity (WAC), oil absorption capacity (OAC), emulsification, swelling power, solubility and bulk density are 7.16 ml/g, 3.63 ml/g, 4.5 ml/g, 6.70 per cent, 7.5 per cent and 0.64 g/ml respectively. Food formulation contained moisture (5.0%), protein (18.6g/100g), fat (5.8g/100g), carbohydrate (67.3g/100g) energy value (396 kcal/100g), crude fiber (11.0%), total dietary fiber (10.45%), ash (3.32%), calcium (308.66mg/100g), iron (6.89mg/100g), β-carotene (1123.5 µg/100g), Zinc (1.89mg/100g), Phosphorous (277.66mg/100g), potassium (54.06mg/100g) and sodium (2.53mg/100g). Hence formulation can be used in the management weight in overweight home makers.

Keywords

Nutritional Evaluation of Food Formulation

Introduction

BMI above 24 and within 30 is considered as overweight. If this overweight is not taken care, it may lead to obesity and other complications. Obesity is the most prevalent nutritional disorder in prosperous communities and is the result of an incorrect energy balance leading to an increased storage of energy, mainly as fat. It is the most common nutritional disorder among the higher socio- economic group in developing and developed countries. In India, the increased levels of obesity are primarily associated with the transformation from rural to urban life- style. Modern lifestyle associated with easy access to food, lack of exercise, sedentary lifestyles, calorie dense foods and excessive television viewing contribute to development of NCDs. Women generally have lower levels of physical activity compared to men. They also are more likely to have a change (either an increase or a decrease) in calorie intake in their lifetime.

Overweight and obesity are defined as abnormal or excessive fat accumulation that may impair health. Body mass index (BMI) is a simple index of weight-for-height that is commonly used to classify overweight and obesity in adults. It is defined as a person's

weight in kilograms divided by the square of his height in meters (kg/m^2) (WHO).

The main treatment for obesity is dieting, augmented by physical exercise and supported by cognitive behavioral therapy. Calorie-restriction strategies are one of the most common dietary plans. Low-calorie diet refers to a diet with a total dietary calorie intake of 800–1500, while very low-calorie diet has less than 800 calories daily.

These dietary regimes need to be balanced in macronutrients, vitamins, and minerals. Fifty-five percent of the dietary calories should come from carbohydrates, 10% from proteins, and 30% from fats, of which 10% of total fat consist of saturated fats. After reaching the desired body weight, the amount of dietary calories consumed can be increased gradually to maintain a balance between calories consumed and calories expended.

Regular physical exercise enhances the efficiency of diet through increase in the satiating efficiency of a fixed meal, and is useful for maintaining diet-induced weight loss (Fock and Khoo, 2013). Hence a study was conducted to develop the formulation which help in weight reduction and analyze its nutritive value.

Materials and Methods

Materials

Ingredients such as foxtail millet (*Setaria italic*), amaranth seeds (*Amaranthus*), green gram *(Vigna radiata)*, wheat *(Triticum spp)*, finger millet (*Eleusine coracana*), flax seeds (*Linum usitatissimum*), skim milk powder, almonds *(Prunus dulcis)*, wheat bran, carrot *(Daucus carota)*, drumstick leaves *(Moringa oleifera)* were selected for the development of food formulation.

Methods

All the ingredients were procured from the local market, cleaned and stored in air tight containers for further use. Suitable pre-treatments like germination, drying, pulverization and roasting were done prior to the formulation development. These ingredients were used in different proportions to develop the formulation (Fig. 1).

Functional properties of food formulation

Swelling power and solubility

Swelling power and solubility were carried out in the temperature ranges of 55 - 95°C, using the method of Leach *et al.,* (1959). 0.1 g of samples were accurately weighed and quantitatively transferred into a clear dried test tube and weighed (W1). 10 cm^3 of distilled water was added to the test tube and the mixture was mixed thoroughly with a variwhirl mixture for 30s. The resultant slurries were heated at desired temperature varied between 55°C and 95°C for 30 minutes in a water bath (using temperature regulated water bath). The mixture was cooled to room temperature and centrifuged (5000 rpm for 15 min). The residue obtained from the above experiment (after centrifuge) with water it retained and test tube was weighed (W2).

$$\text{Swelling power} = \frac{W2 - W1}{\text{Weight of sample}}$$

Aliquots (15ml) of the supernatant obtained after centrifugation were dried to a constant weight at 110°C. The residue obtained after drying the supernatant the amount solubilised in water. Solubility was calculated as gram/ 100gm on dried weight basis.

Water and oil absorption capacity (Rosario and Flores, 1981)

One gram sample was mixed with 10ml of either distilled water or in 15ml oil for 30min. The contents were allowed to stand at 30ºC in a water bath for 30min and then centrifuged at 3000-5000 rpm for 20-30 min. After centrifuging the volume of the supernatant was recorded and used for determination of water and oil absorption and the results were expressed as g/g sample.

Bulk density (Wang and Kinsella, 1976)

Ten ml capacity graduated cylinder was filled with the sample. This was done by gently tapping the bottom of the cylinder on the laboratory bench several times until there is no further diminution of the sample level after filling to the 10 ml mark.

$$\text{Bulk Density (g/ml)} = \frac{\text{Weight of sample (g)}}{\text{Volume of sample (ml)}}$$

Nutritional evaluation of food formulation

The developed formulation was analyzed for macronutrients such as moisture, protein, fat, crude fiber, dietary fiber and ash and micronutrients such as calcium, iron, phosphorous, zinc sodium and β-carotene using standard procedure of AOAC, (1990). Carbohydrate and energy contents were computed. The samples were worked in triplicates and average values were recorded.

Results and Discussion

Functional properties of low calorie food formulation per 100g

Functional properties are those parameters that determine the application and use of food material for various food products (Adebowale *et al.*, 2012). Functional properties of low calorie food formulation per 100 gram are given in the Table 1. Mean values for water absorption capacity (WAC), oil absorption capacity (OAC), emulsification, swelling power, solubility and bulk density are 7.16 ml/g, 3.63 ml/g, 4.5 ml/g, 6.70 per cent, 7.5 per cent and 0.64 g/ml respectively. Similarly Devisetti *et al.*, (2014) found that foxtail millet flour obtained from brown seeds without polishing had highest water and oil absorption capacity, emulsion activity and stability, and foaming capacity.

Water absorption capacity (WAC) improves the reconstitution ability and textural properties of dough. High WAC is also attributed to loose structure of starch polymers while low value indicates the compactness of the structure (Adebowale *et al.*, 2012), indicating present formulation has better compactness of the structure.

Oil absorption capacity (OAC) of the formulation depends on the presence of non-polar side chain, which binds hydrocarbon side chain of the oil among the flours. OAC is potentially useful in structural interaction in food especially in flavor retention, improvement in palatability and extension of shelf life particularly in bakery and meat products where fat absorption is desired.

Emulsification is the maximum amount of oil emulsified by protein in the given amount of flour. Emulsification of flour makes it better to be used in food formulation like snacks, pastries, coffee whiteners and frozen desserts (Shad *et al.*, 2013).

Swelling capacity and solubility of flours depends on size of particles and types of processing methods. As reported by Chandra *et al.*, (2015) parboiled rice has more

swelling capacity as compared to raw rice. Swelling capacity of composite flours increased with increase in the level of incorporation of rice, green gram and potato flour and decreased with the level of wheat flour. It is also affected by the starch content.

Bulk density of the multigrain ready to eat snack mix from minor cereals is 0.66 g.ml, which indicates fluffy nature of the mix (Pradeep, *et al.,* 2013). Dehulling and subsequent removal of bran has a significant effect on the bulk density of the flours in milled fractions.

The bulk density is generally affected by the particle size and density of flour or flour blends and it is very important in determining the packaging requirement, raw material handling and application in wet processing in the food industry (Adebowale *et al.,* 2012). These research findings support the findings of the present study.

Nutrient composition of food formulation

Macronutrient composition

Food intake has been associated with obesity not only in terms of the volume of food ingested but also in terms of the composition and quality of diet. Furthermore, eating habits have also changed and current habits include low consumption of fruits, green vegetables, and milk; increasing consumption of snacks, sweets, and soft drinks; and skipping breakfast; these eating habits result in continuous increase in adiposity. Eating habits in addition to environmental differentials represent the most dominant determinant in increasing the tendency of overweight and obesity and modification in the eating habits may be singleton strategy to a more appropriate weight control (Amin *et al.,* 2008).

Table 2 shows the macronutrient composition of low calorie food formulation per 100g. Moisture content of the developed formulation was 5.0 per cent and found to be a good source of protein (18.6 %). The developed formulation contained 67.3% of carbohydrate and provided 396 Kcal/100g. According to a study conducted by Jayamani *et al.,* (2013), women who consumed high calories were found to be overweight/ obese.

Higher protein content was due to the incorporation of millets, pulses and milk powder, which are the rich sources of protein. Fat content of developed flour was 5.8 per cent. Similar findings were reported by Kanapal *et al.,* (2015) who found 5.53 per cent of fat in high fiber bread developed with oat and sweet potato.

A high protein diet is associated with increase in dietary induced thermogenesis and modest reductions in digestible energy. High protein diets are associated with increased satiety.

Also negative energy balance is achieved with a high protein diet due to decreased energy intake. Hence most of the strategies for weight loss include high protein low carbohydrate diets (Jebb, 2005). This clearly supports the present food formulation which has good amounts of protein and contributed toward weight reduction.

An energy dense, high fat diet and low levels of daily physical activity are independent risk factors of weight gain and obesity in genetically predisposed individuals.

Important interactions may exist between genetic makeup, dietary fat and physical fitness, so that a low fitness level reduces muscular fat oxidation capacity, which may decrease the tolerance of dietary fat.

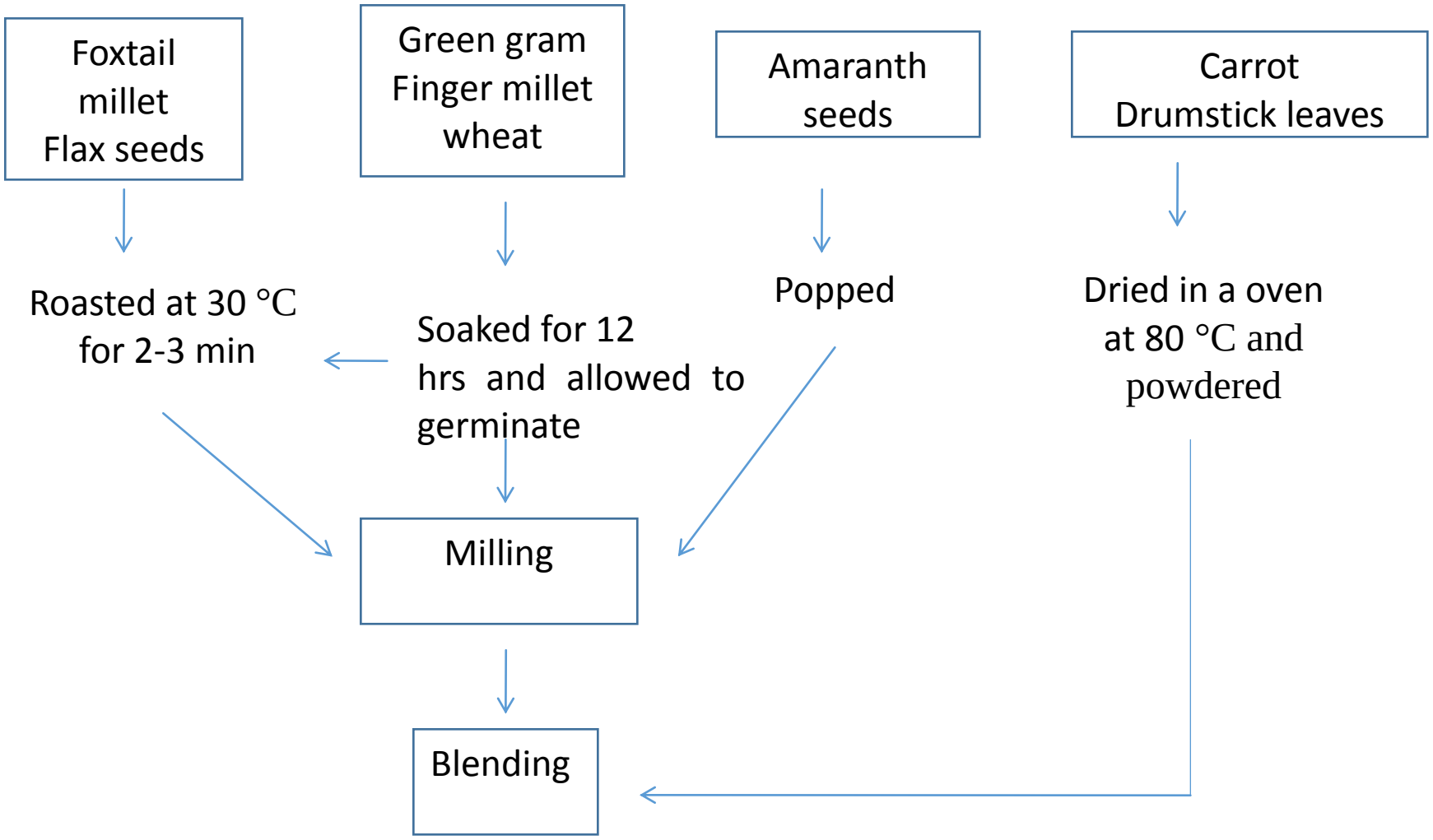

Fig.1 Flow chart for the preparation of low calorie food formulation

Table.1 Functional properties of low calorie food formulation per 100g

Functional properties	Mean
Water absorption capacity (ml/g)	7.16
Oil absorption capacity (ml/g)	3.63
Emulsification (ml/g)	4.5
Swelling power (%)	6.69
Solubility (%)	7.5
Bulk density (g/ml)	0.64

Table.2 Macronutrient composition of food formulation per 100g

Nutrient	Mean value
Moisture (%)	5.0
Protein (%)	18.6
Fat (%)	5.8
Crude fiber (%)	11.0
Total dietary fiber (%)	10.45
Soluble	1.1
Insoluble	9.35
Ash (%)	3.32
Carbohydrate (%)	67.3
Energy (Kcal)	396

Table.3 Micro nutrient composition of food formulation per 100g

Nutrient	Mean value
Calcium (mg)	308.66
Phosphorus (mg)	277.66
Iron (mg)	6.89
Sodium (mg)	2.53
Potassium (mg)	54.06
Copper (mg)	0.66
Zinc (mg)	1.89
Mangnese (mg)	1.65
β -carotene (µg)	1123.5

The formulation contained good amount of crude fiber (11%), soluble dietary fiber (1.1%), insoluble dietary fiber (9.35%), ash (3.32%) and carbohydrate (67.3%) and provides 396 kcal of energy. Slightly lower values are reported by Pradeep *et al.,* (2013) reported that the ready to eat snack mix prepared using minor millets contained 14.0±0.07 g of protein, 14.5±0.72 g fat, 59.0±1.20 g of carbohydrates and 6.3±0.04 g of dietary fiber per 100 g of mix. Fiber reduces energy density as it contributes more to food weight than to caloric content. Dietary fiber intake is associated with lower food intake by adding bulk to the food, leads to slower gastric emptying and slower rate

of nutrient absorption and also reduces the energy density of the diet. Hence increasing dietary fiber aids in weight management (Choudary and Grover, 2012).

Whole grain cereals and dietary fiber in particular promote satiety, prolong gastric emptying time and slow down nutrient absorption. This in turn helps in moderate rate of glucose absorption, delayed insulin release, and consequently influences the weight management (Patel, 2015).

Dietary intervention is the cornerstone of weight loss therapy. Most of the dietary regimens proposed for weight loss focus on energy content and macronutrient composition. The carbohydrate content of the diet is an important determinant of weight loss. Low carbohydrate content of the diet increases the glycogen (stored form) utilization and results in fluid loss. Limited carbohydrate intake also increases the intake of protein, which serve as an alternative source of energy. Triglycerides and high-density lipoprotein (HDL) cholesterol changed more favorably with low-fat diet (Fock and Khoo, 2013). Dietary protein was found to be effective in increasing satiety and aiding weight loss and also provided additional advantage of decreasing the cardiovascular risk factor (Anderson and Moore, 2004).

Micronutrient composition

High consumption of fast foods, soft drinks and sweets, and less intake of fruits and leafy vegetables are associated with obesity and may also lead to micronutrient deficiency. Micronutrient deficiencies are linked to a higher risk of overweight and obesity including other debilitating diseases, which can also have long-term consequences (Khadilkar *et al.,* 2012) on health.

Micronutrient content of the low calorie food formulation per 100g is presented in Table 3. The formulation contained significant amount of calcium (308.66 mg), phosphorous (277.66 mg), iron (6.89), sodium (2.53mg), potassium (54.06mg), copper (0.66mg), zinc (1.89 mg), manganese (1.65mg) and β-carotene (1123.5 µg). Above micronutrient make developed formulation as a very good nutra dense formulation to manage weight. High calcium, iron and moderate β-carotene content makes this formulation as a very good dietary supplement to manage weight.

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