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Re-Engineering of Traditional Indian Wadi into Ready-to-Use High Protein Quality and Fibre Rich Chunk

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***Abstract*—**In the present study an attempt has been made to re-engineer traditional wadi into wholesome ready-to-use cereal-pulse-based chunks rich in protein quality and fibre content. Chunks were made using extrusion-dehydration combination. Two formulations i.e., whole green gram dhal with instant oats and washed green gram dhal with whole oats were formulated. These chunks are versatile in nature as they can be easily incorporated in day-to-day home-made preparations such as pulao, potato curry and kadhi. Cereal-pulse ratio was calculated using NDpCal%. Limiting amino acids such as lysine, tryptophan, methionine, cysteine and threonine were calculated for maximum amino acid profile in cereal-pulse combination. Time-temperature combination for extrusion at 130°C and dehydration at 65°C for 7 hours and 15 minutes were standardized to obtain maximum protein and fibre content. Proximate analysis such as moisture, fat and ash content were analyzed. Protein content of formulation was 62.10% and 68.50% respectively. Fibre content of formulations was 2.99% and 2.45%, respectively. Using a 5-point hedonic scale, consumer preference trials of 102 consumers were conducted and analyzed. Evaluation of chunks prepared in potato curry, kadi and pulao showed preferences for colour 82%, 87%, 86%, texture and consistency 80%, 81%, 88%, flavour and aroma 74%, 82%, 86%, after taste 70%, 75%, 86% and overall acceptability 77%, 75%, 88% respectively. High temperature inactivates antinutritional compounds such as trypsin inhibitors, lectins, saponins etc. Hence, availability of protein content was increased. Developed products were palatable and easy to prepare.

***Keywords*—**Extrusion, NDpCal%, protein quality, wadi.

I. Introduction

PROTEINS are biomolecules or macromolecules which consist of large chains of amino acids. Proteins perform a great variety of specialized and essential functions in living systems. Around 300 amino acids are well known in nature. Out these 300, only 20 amino acids holds utmost importance as they are repeatedly found in the structure of proteins when isolated from different forms of life- animal, plants and microbes [6]. The essential amino acids are abundantly present in plant source such as cereals, pulses, nuts and oilseeds. Some of the common examples of cereals are wheat, ragi, oats, bajra, rice etc. whereas pulses include Bengal gram dhal, cow pea, green gram dhal, black gram dhal, soybean etc. Nuts and oilseeds include almond, walnuts, pistachio, cashew nut, groundnut etc. The type, amount, presence and sequencing of amino acids in protein structures vary from source to source; hence, the need for protein quality arises in a diet.

Protein quality refers to the consumed amount of protein available to the body for its metabolic usage, and therefore, when all the essential amino acids are consumed in the same meal, the availability and absorption of all amino acids are considered to be optimum. Otherwise, missing of even one amino acid will hamper in the absorption of others. Therefore, food should be consumed in combinations and proportions which will result in optimum absorption of all amino acids and in-turn helps in proper metabolic functions. Cereals are deficient in lysine and pulses are deficient in methionine. Both these amino acids are essential amino acids. Consumption of food which is a combination of cereal and pulse will result in optimum protein quality.

Protein quality is estimated using net dietary protein calorie percent [NDpCal%]. NDpCal% depicts the protein requirement to be met in relation to the total energy consumed by an individual through dietary sources. Therefore, the ratio of cereal is to pulse is calculated to arrive at nutritionally adequate quality protein [4].

Wadi is a popular traditional Indian product which is solely made up of pulse. It is made up of husked or dehusked pulses which are prepared by drying, mainly sun drying. In the present investigation, attempts have been directed towards the development of cereal-pulse based wadi/chunks to augment protein quality and fibre in the existing Indian wadi/chunks. It is a versatile product in terms of its usage, as it can be incorporated in potato curry, pulao or can replace fried pakoras in kadhi etc.

II. Method and Materials

Pulse such as whole and washed green gram dhal along with cereal such as whole and instant oats with added salt and other spices were extruded and dehydrated. Fig. 1 shows brief flow chart of the employed method. Green gram dhal is very well known for its easy digestibility, low flatulence and high protein content [2]. Two variants were produced and consumer preference trials were conducted in different preparations.

A. Processing of Green Gram Dhal and Oats

Insect and pest free green gram dhal of all two varieties i.e., whole and washed were procured. Whole and instant oats were used.

Two formulation of green gram dhal were twin screw extruded. Sample 1 consists of whole green gram dhal and

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instant oats and Sample 2 consist of washed green gram dhal with whole oats. Ratio of ingredients weighed using electronic weighing balance was calculated on the basis of NDpCal%. Both the ingredients for each sample were milled separately into flour and sieved from sieve no. 3.

B. Preparation for Twin Screw Extrusion

Twin screw extruder was used at National Dairy Research Institute, Karnal, Haryana, India. Using Pearson square method, appropriate amount of potable water was added to milled flour and mixed properly. The moistened flour was then subjected to sieving. Mesh size no. 60 was used. Kashmiri lal mirch and salt was added. Flour was mixed after adding spices and salt. This mixture was sieved using sieve of mesh size no. 60.

C. Twin Screw Extrusion

The prepared mixture was extruded in twin screw extruder (BTPL-Lab Model, Size- R 82Z DC 132S-4, Year- 2010, H.P.- 7.5, Speed- 291, No.- 6/ 41046, Manufactured by- new Allenberry Works, Calcutta, D.C Motor, Model- M5F) at 130° C. The produced mass was collected.

D. Milling of Extruded Product

The extruded product achieved was milled and converted into flour. Sieve no. 3 was used to sieve the flour. The flour was mixed thoroughly with Kasuri methi.

E. Dough Formation

Clean, dried and alcohol sanitized planetary mixer was used for dough formation. Appropriate quantity of potable water was used to make soft dough.

F. Moulding

Moulder was used to give shape to the dough.

G. Dehydration

The product was dehydrated in a tray dehydrator at 65 °C for 7 hours 15 minutes. Chunks were cooled at 28-30 °C. Fig. 2 shows developed extruded dehydrated chunks.

H. Packaging

250g of chunks were packed in polyethylene pouches.

III. Results and Discussion

A. Physical Parameter

Consumer preference trials were conducted. Sensory evaluation was done using 5-point hedonic scale. Parameters rated were colour, texture, flavour, aroma and overall acceptability. Product was well received by consumers (Fig. 3).

B. Chemical Parameter

Table I shows proximate analysis of developed extruded-dehydrated ready-to-use chunks.

Moisture content of Sample 1 and Sample 2 were 2.43% and 2.38%, respectively. The variations of moisture content among all samples were marginal and insignificant. This difference is due to difference in ingredients used and their moisture uptake ability. According to US Department of Agriculture, dehydrated products are those products which contain moisture content not more than 2.5% (dry basis). Moisture, percent by mass, max., should be 6%. The present products confirms to above specifications.

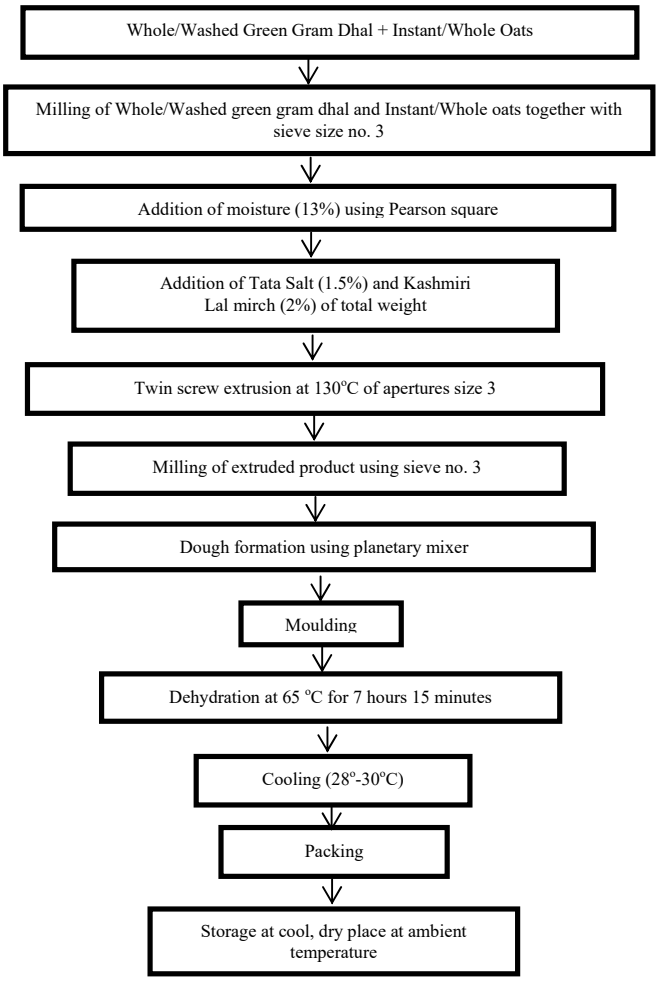

Fig. 1 Process flow chart

Fig. 2 Developed Ready-to-Use chunks

Ash content obtained for Sample 1 and Sample 2 was 2.86%. Total ash content, percent by mass, max. should be 5.0%. The present products confirms to above specification [1].

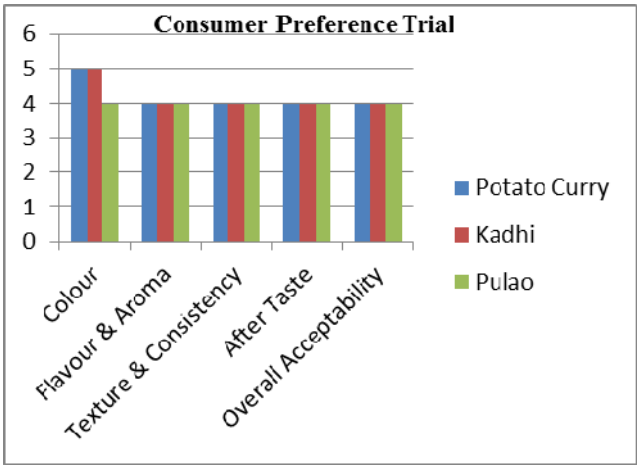

Fig. 3 Scores for different organoleptic attributes for Sample 1 and Sample 2 during consumer preference trials

The fat content of Sample 1 and Sample 2 were 2.01% and 1.75%, respectively. Fat content decreases from sample 1 to 2 i.e. 2.01% to 1.75%. Similar research were conducted by Fabriani et al. showed the decrease in fat content is due decrease in extractable fat content of extruded pasta products as a result of complexation and/or shear [3].

The protein content of developed Sample 1 and Sample 2 were 62.10% and 68.50% respectively. Protein content of washed green gram dhal is more than whole green gram dhal by 0.5 g/100 g. During extrusion, absence of outer shell in washed green gram dhal led to easy denaturation of protein and hence more availability of protein in Sample 2 than Sample 1 [5]. BIS IS: 9487-1980 for protein content states that, percent by mass of protein content should be 16% [1].

Crude fibre content of Sample 1 and Sample 2 were 2.99% and 2.45%, respectively. Decrease in fibre content is due to increased removal of outer layers of the grain. Very few studies have been conducted on the effect of extrusion cooking on dietary fibre. Some researchers concluded that degradation of fibre may occur in processes like extrusion that involves shear [7]. Despite the variation in type of oats used, the crude fibre content was same and was not affected by extrusion. Crude fibre content (on dry basis), percent by mass should be 3.00% maximum [1].

TABLE I
PROXIMATE ANALYSIS OF DEVELOPED PRODUCT

Proximate Parameters	Whole Green Gram dhal + Instant oats (Sample 1) (%)	Washed Green Gram Dhal + Whole oats (Sample 2) (%)
Moisture	2.43	2.38
Ash	2.89	2.86
Fat	2.01	1.75
Protein	62.10	68.50
Crude Fibre	2.99	2.45

C. Microbiological Parameter

Microbiological parameters such as total plate count, yeast and mould count, *E. coli* count and Coliform count were conducted. The results obtained showed that both samples microbiological parameters were non-detectable. This indicates that good hygiene is maintained throughout the process formulation.

1. Statistical Analysis

The sample size calculated was 102 at 95% confidence level.

D. Consumer Preference Trials

The acceptability of the product by the target population is an important factor in determining its market viability. The samples were evaluated by 102 consumers for appearance, taste, colour, texture, aroma, and over acceptability. The product was rated on 5-point hedonic scale. Fig. 3 shows consumer preference responses. Both samples were accepted in their end preparations for colour, flavour and aroma, texture and consistency, after taste and overall acceptability. Colour of Sample 1 in kadhi and Sample 2 in potato curry preparation was excellent whereas Sample 1 in pulao was very good. Consumer preference trials showed great potential of the product as it was highly accepted by various age grouped individuals. Figs. 4-6 show developed chunks in their end use preparations.

Fig. 4 Sample 1 in pulao preparation

Fig. 5 Sample 1 in kadhi preparation

Fig. 6 Sample 2 in potato curry preparation

IV. Conclusion

Extrusion cooking is one of the easiest and economical methods for the production of ready-to-use products. The same technology has been utilized in the re-engineering of traditional Indian chunks, commonly called as wadi. The conditions used during extrusion such as high moisture content, low residence time, aperture size, moderate temperature etc. have resulted in many nutritional advantages such as increased protein content, higher retention of amino acid especially lysine, easy starch digestibility etc. There is a huge rise in demand for ready-to-use, easy, time saving and nutritionally adequate wholesome food products round the globe. Chunks developed using extrusion technology fulfills changing requirements of the common man. Consumer preference trials showed that chunks were highly acceptable among various age groups.

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