

Cereal - Pulse Fermentations Using Soyabean - An Innovative Experimentation

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Abstract: Fermented foods have been consumed by mankind since time immemorial. Fermentation is known to improve the nutrient quantity and quality of the foods. Cereal pulse mix is useful in enhancing the protein quality. This study was done to develop innovative fermented cereal pulse dishes using soyabean. Soya bean was fermented with four cereals namely Rice, Wheat, Ragi and Oats in the cereal pulse ratio 70:30. Three standard Indian fermented foods namely dosa, Idli and pakora were chosen for experimentation due to its familiarity. Four different cereals in combination with Soyabean was fermented and prepared into the three dish totalling to 12 dishes. Acceptability of the dishes was tested using organoleptic analysis. Chemical score and Net Dietary Protein calorie % was computed to analyse the protein quality of the preparations. Rice- soya combination had maximum acceptability for dosa and idli preparation. Wheat-soya combination was the most accepted pakora preparation. Lysine was the most limiting amino acid in all the dishes. The NDPCal% of all the variations was above the recommended 8% indicating its ability in supporting growth especially in children and adolescents. Hence incorporation of Soya based fermented foods in Indian diet is a healthy and innovative substitute that will aid in growth promotion.

Keyword: Chemical score, Fermented foods, NDP Cal%, Protein Quality, Soyabean.

I. Introduction

Fermented foods, whether from plant or animal origin, have been an intrinsic part of the diet of the people in all parts of the world. Globally, there are varieties in fermented foods and beverages and so do the ingredients and recipes for making them. For instance, in Russia, a slightly sour weak beer called *Kvass* is made from rye flour and malt. In Australia *Kefyr* is made from milk with the help of a Mushroom variety [1]. Basically, fermented foods are agricultural products which have been converted by enzymatic activities of microorganisms into desirable food products in terms of nutritional value as well as keeping qualities.

Out of all the preservation techniques, fermentation is the only type that does not destroy some nutrients, can create more, and enhance others. Omega 3 fatty acids, detoxifying agents and many B vitamins including folic acid, riboflavin, niacin, thiamin, and biotin are preserved through fermentation. Fermented soy is known to stop the effect of phytic acid and increase the availability of isoflavones. It also creates probiotics, the "good" bacteria that our body is absolutely dependent on, such as lactobacilli, which increases the quantity, availability, digestibility and assimilation of nutrients in our body

Fermented foods are popular throughout the world and in some regions make a significant contribution to the diet of millions of individuals. The earliest evidence of wine making dates from eight thousand years ago, in Georgia. In the Indian subcontinent, making and use of fermented food and beverages using local food crops and other biological resources is very common amongst the high landers of Himalaya, though the name of the products and the base material vary from region to region [2].

Food fermentations gain importance in developing countries where the lack of resources limits the use of technologies such as vitamin enrichment of foods. Some important indigenous fermented foods of India are *Bhallae* (Black gram Product), *Bhatura* (White Wheat flour Product), *Dhokla* (Bengal gram Product), *Dosa* and *Idli* (Rice and Black gram product), *Papadam* (Black gram Product) etc [3].

Most commonly cereals are used as fermentable substrates for the growth of probiotic microorganisms. The agro- science needed to produce cereal crops sufficient to meet the world food energy requirements for the new millennium is currently available. However, protein supplementation of cereals is desirable in many instances because cereals have low protein content and are imbalanced in essential amino acid composition. As a result, cereal grains alone do not supply adequate protein for satisfactory growth of infants and children, nor for the bodily maintenance of adults. Soy protein products are an ideal source of some of the essential amino acids used to complement cereal proteins. At present, soy proteins are considered more versatile than many other food proteins in various worldwide nutrition programs.

In the current scenario of price rise, there is strong need for using low-cost vegetable sources of protein in the world economy. This has changed the focus on vegetable proteins like soy in food formulations. Soya beans have great potential for use as human food because of their high level of good quality protein and

their unique functional and nutritional properties. One of the most promising uses of soyabeans is the fortification of cereal based products such as fermentation because the profile in essential amino acids in soy is complementary to that in most cereals. Protein malnutrition is a serious problem in India whose diets consist mainly of cereal or starchy food leading to limited supply of high-quality protein for the average person

The possibility of developing low cost nutritionally superior food stuffs and soy fermented foods in Indian diets is an appealing and challenging area to explore. Hence developing new and healthier fermented food products incorporating soybeans interestingly modifies the traditional South Indian fermented foods and thus this study entitled "Cereal-pulse fermentations using Soyabean - An Innovative experimentation" was done.

II. Methodology

2.1 Choice of food

In a quest to develop innovative fermented foods, combination of soyabean with four different cereals like rice, wheat, ragi (Finger Millet) and oats was chosen. All the food stuffs were locally available, less expensive and also nutritive.

Soy protein is considered nutritional equivalent of meat, eggs, and casein for human growth and health. The US Food and Drug Administration, propagates soy protein products as good substitutes for animal products because it offers a 'complete' protein profile. Rice is a staple diet for more than half of the world's population. Rice, being the staple in south Indian diet and the versatility of the rice fermented products already existing lead to the selection of rice as one of the ingredient.

Wheat is a staple in North Indian diet. There is very little literature pertaining to use of wheat as a fermented food in combination with pulses. Thus wheat was intended for use. Oats, generally considered "healthy" is touted commercially as nutritious. Being a novel food, fermented preparations of oats with pulse combination has not been much experimented with. Ragi is the common name of Finger Millet in South India. It is one of the most nutritious food and easy to digest. It is rich in calcium and protein and also has good amount of iron and other minerals. The low cost of ragi makes it a highly affordable source of high-class nutrition. Hence ragi was chosen as an ingredient to explore its use by fermenting in combination with pulses

Chemical analysis has shown that the amino acids deficient in the legumes are generally adequately compensated by the protein of cereals and vice versa. The mutual compensation is closest to ideal when the ratio by mass of cereal to legume is roughly 70:30, in which proportion each provides about equal parts by mass of protein.[4]. Thus a proportion of 70:30 (70 of cereals and 30 of soybean) was used for all the combinations.

2.2 Formulation of Recipes

Four combinations of rice, ragi, oats and wheat with soybean were prepared into 3 well known preparations, Dosa (a roasted pancake), idli (steamed cake) and pakoras (a deep fried snack). A total of 12 recipes were prepared with 3 dishes in four variations each.

The organoleptic evaluation of all the 12 preparations was conducted by 25 women in the age group of 25- 45 years. A five point numerical score card was used on a scale of 1-5 ranging from poor to excellent to rate in terms of appearance, taste and texture and was totaled to know the five most acceptable variation.

2.3 Evaluation of protein quality

Chemical methods based on the amino acid composition are used to evaluate protein quality. If the composition of an 'ideal' protein i.e., the one containing all the essential amino acids in amounts sufficient to meet requirements without any excess, are known, it is then possible to compute the nutritional quality of a protein or a mixture of a protein by calculating the deficit of each essential amino acid below the amount in the ideal protein. This approach is the basis of the so called amino acid scoring (chemical score) procedure, by which one can evaluate the capacity of a given protein or mixture of proteins to meet the essential amino acid and nitrogen requirement of an individual.

Chemical score of all the selected combinations are expressed as the ratio of each essential amino acid in a test protein to the respective amino acid in the reference protein. The reference protein used was suggested pattern of amino acid (SAAP) requirement of in mg/g of protein given by FAO/WHO [5]:

$$\text{Chemical score (CS)} = \frac{\text{mg of amino acid in 1g total nitrogen of test food}}{\text{mg of amino acid in 1g total nitrogen of reference protein}} \times 100 \quad (1)$$

The Net Dietary Protein Calories per cent (NDPCal%) of the five most acceptable variation was calculated. It relates protein quality to the energy intake. It is useful to evaluate if the protein needs of an individual would be

adequately met based on the energy consumed. NDP cal% is the net dietary protein value expressed as per cent of total calories:

$$NDPCal\% = \frac{\text{Protein calories}}{\text{Total calories}} \times \text{chemical score} \quad (2)$$

III. Results and Discussion

3.1 Organoleptic Evaluation

Sensory scores for the different variations were computed. Dosa and idli preparation using rice and soyabean had maximum acceptability with mean scores 11.2 and 13 respectively among the four variations. With regard to Pakora preparation, wheat-soya combination was the most acceptable with score 12.2 as shown in TABLE 1.

TABLE 1
Mean Acceptability Scores of the different variations

Cereal-pulse mixes	Dosa	Idli	Pakora
Rice- soya	11.2	13	8.6
Ragi-soya	9	8.5	7.8
Oats Soya	10.2	8.7	7.6
Wheat-soya	10.6	6.3	12.2

However with regard to individual attributes for dosa, Oats-soya combination had high scores for appearance (4.2) and Wheat-soya was scored very good (4.3) for taste. The variation with Ragi however was least acceptable with low scores for all the attributes. On calculating the total scores, Rice and soybean Dosa was the most acceptable with a score of 11.2. This was closely followed by Wheat (10.6) and Oats (10.2) variations.

Idli, a soft textured South Indian dish suitable for a light breakfast is originally, a rice and black gram dhal mix. In the current study, a variation was tried by incorporating soyabean as the pulse along with rice and had excellent rating for taste and was also the most acceptable variation. The other three variations of Idli had comparatively less scores. Pakora is a highly savored, deep fried snack usually made with Bengal gram flour. The wheat soya variation scored high in all attributes like appearance, taste and texture and hence was considered most acceptable among all the variations in pakora.

3.2 Protein Quality

From a total of 12 recipes, five top preparations with a mean acceptability score more than 10 were chosen for computation of amino acid content, chemical score and the protein quality was assessed and is as presented in TABLE 2.

TABLE 2
Protein quality of the five most acceptable preparations

Cereal-Pulse Mixes	Dosa		Idli		Pakora	
	LAA, CS	NDPCal %	LAA, CS	NDP Cal %	LAA, CS	NDP Cal%
Rice- Soya	Ly, 97.4	12.5	Ly, 97.4	18.5	NC	NC
Oats-Soya	Ly, 90.1	14.2	NC	NC	NC	NC
Wheat-soya	Ly, 85.2	13.2	NC	NC	Ly, 85.2	9.9

LAA-Limiting Amino Acid, CS- Chemical score, Ly- Lysine, NC- Not calculated

Lysine was found to be the most limiting amino acid in all the selected variations. Soyabean is known to be a good source of amino acid lysine when compared to cereals like rice, wheat etc. In spite of inclusion of soyabean along with a cereal, it was found to be deficient in essential amino acid lysine. However the NDP Cal % (i.e the calorie contribution of protein in the diet) for the all the five most acceptable variation was above the recommended. The ideal NDP Cal% to support growth is 8%. The NDP cal% of dosa with rice, oats, and wheat with soya was 12.5%, 14.2% and 13.2% respectively. Rice-soya idli had an NDP cal% of 18.5% and wheat-soya pakora was 9.9%. This shows that all the dishes had an NDP cal% more than 8% which is evidence that the dishes in selected combinations could sufficiently support the growth of an individual.

IV. Conclusion

Fermentation is a time tested method of food preservation. It is also a low cost method to enhance the nutritive value of food stuffs and hence gains significance in the context of developing countries like India. A cereal pulse mix in the ideal proportion can aid in providing all the essential amino acids in the right quantity. Soyabean, a good vegetarian source of protein when mixed along with cereals can help in improving the biological value of protein and can help in reducing the incidence of protein energy malnutrition. Hence this study opens up a huge market potential to introduce soya based cereal fermented foods in the Indian market. There is also more scope for assessing the health impact of such innovative fermented combinations in supporting the growth of young children and adolescents.

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