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Formulation of multigrain vermicelli for people living with HIV

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Abstract
Adequate nutrition for a person living HIV (PLHIV) is necessary to maintain and improve the overall health and nutritional status. In an attempt to improve the nutritional quality of breakfast products sold in the market and to suit various therapeutic conditions a multigrain vermicelli was developed. This product was assessed for its functional, nutritional properties and consumer acceptability. The multigrain's namely wheat, rice bran, maida, jowar, varagu, ragi, corn, maize, green gram, dry green peas, soya bean and horse gram, Bengal gram were purchased from the local market, cleaned, roasted and powdered. Careful calculation was carried out to bring out the variation of multigrain's to be used for making the flour. Finally three variations coded as V_1, V_2 and V_3 were taken along with white flour in the ratio of 100, 75:25 and 50:50 respectively. The extrudates were prepared using one screw extruder at a speed of 50 rpm, 80-140 ^{0}C temperature and 0.33 of die diameter. The flour samples were packed and tested for nutrients namely carbohydrate, protein, fat, fiber and energy and physiochemical properties (moisture, bulk density, lateral expansion, water absorption index, water solubility index and swelling power) and shelf life using standard procedure. Further the vermicelli developed with the three variations were used for preparation of uppuma and evaluated for sensory and consumer acceptability. Among the three variation V_3 had the finest nutrient composition and physiochemical properties and V_1 had the highest nutrient composition followed by V_2. The consumer acceptability was high for the dish prepared with V_3. Thus the developed multigrain vermicelli can be used as an alternate ready to eat breakfast products with potential health benefits for PLHIV.

Keywords: Multigrain vermicelli, nutritional composition analysis, sensory evaluation.

1. Introduction
HIV infection increased susceptibility to other infections, when this is compounded by a lack of food, progressive malnutrition ensues. Weight loss and low BMI, especially when associated with low CD4 cell counts, are strong and independent predictors of survival in HIV infection Mangili *et al*., (2006) [1]. Fauzie (2004) [2] says that nutrition plays a crucial role throughout the course of HIV disease. People living with HIV and those with AIDS require more energy and more protein, along with the necessary micronutrients, than the people who are not HIV infected. According to Macallan (1999) [3] and WHO (2003) [4] HIV-positive individuals are prone to malnutrition due to inadequate dietary intake, nutritional losses, metabolic changes, and increased requirements for both macro- and micro-nutrients. Knox *et al.,* (2003) [5]. And Tang *et al.,* (2002) [6] reported that the critical role of nutritional support and Highly Active Anti-Retroviral Therapy (HAART) in the survival of HIV-infected individuals is well known.
Cereals are staple food worldwide. To produce nutritious product, cereals are usually fortified with pulse protein. The cereals have a high carbohydrate fraction that includes oligosaccharides, soluble sugar and dietary fiber. Many health benefits are attributed to these components like slow glucose release due to low glycemic index (Rizkalla *et al.* (2002) [7]. These cereals and legumes in a blended form can produce product with high essential amino acid content (Thakur *et al.,* 2000) [8]. Ndekha (2009) [9]. reported that the ready-to-use spread was significantly more effective than corn soy blend in increasing BMI among HIV-infected adults with wasting; no differences in CD4 cell counts, viral loads, or mortality were observed between the 2 groups.
There are few legumes that enhance the biological value of protein and minerals. The most common pulses that provide a rich source of nutrients are soy bean, green gram, Bengal gram, Horse gram and peas and each one of these legume have unique health benefits.

Proteins from soya bean reduce the risk of coronary heart disease (Tripathi *et al.,* 2004) [10]. Few common cereals and millets like wheat, bajra, jowar, ragi, varagu and maize are nutrient dense. Ragi is mainly used in preparation of weaning foods and malt because of rich protein, amino acid and high bioavailability of zinc and iron (Subba Rao *et al.,* 2000 and Hemalatha *et al.,* 2007) [11, 12]. Increased interest in incorporating the cereals and pulses in ready to eat food products specifically extrusion which now a days are becoming more popular than other bakery products in ready to eat food category. Extrusion cooking is a popular means of preparing snack foods and ready to eat breakfast cereal (Parsons *et al.,* 1996) [13]. Extrusion cooking of cereals is a very important process in food industries. Since, extruders minimize the operating cost and higher productivity than other cooking process, combing energy efficiency and versatility (Ficarella *et al.* (2004) [14]. Therefore in the present study an attempt has been made to formulate the multigrain vermicelli and analyse the nutrient composition, physiochemical properties and consumer acceptability and thus it can be used as an alternate ready to eat breakfast with potential health benefits for PLHIV.

2. Methodology

2.1 Collection of multigrains

Nutritionally grains are important as they are good source of dietary fibre, protein, carbohydrates and a source of phytonutrients such as lignin's and iso flavones. Hence multigrain was used to develop the vermicelli. The following grains were used for the study wheat, rice bran, maida, jowar, maize, varagu, ragi, bajra, greengram, bengalgram, dry green peas, soya bean and horse gram. The ingredients were cleaned washed and dried. The dried ingredients were roasted slightly. Further the selected ingredients were grounded finely and stored in air tight container except for green gram and bengal gram. These two legumes were germinated for period of 16 hrs. They were dried, roasted, grounded and stored in air tight containers.

2.2 Formulation of the multigrain vermicelli

The formulation for developing a multigrain vermicelli was done with a objective to have a maximum amount of protein, carbohydrate and fiber. The multigrain flour was prepared in three variations. The variation (V_1) had 100 percent of the prepared flour, variation (V_2) had 75 percent of multigrain flour and 25 percent of maida flour and variation (V_3) had 50 percentage of each maida and multigrain flour. The variations used for preparation of vermicelli along with quantity of ingredients used are given in the Table-1 and Plate-1 shows the standard and formulated vermicelli.

Table 1: Variation used for preparation of vermicelli along with quantity of ingredients

Ingredients (g)	Standard	V_1	V_2	V_3
Maida	100	----	25	50
Wheat	-----	20	30	10
Rice bran	-----	10	2.5	5
Maize dry	-----	10	5	5
Jowar	-----	5	5	2.5
Varagu	-----	5	2.5	2.5
Bajra	-----	5	5	2.5
Ragi	-----	5	5	2.5
Green gram (whole)	-----	10	5	5
Bengal gram (whole)	-----	5	2.5	2.5
Horse gram	-----	10	5	5
Green peas dry	-----	10	2.5	5
Soya bean	-----	5	5	2.5
Total	100gm	100gm	100gm	100gm

2.3 Extrudate preparation

The extrusion of samples was performed using a single screw extruder. The barrel was provided with two electric band heaters and one water cooling jackets. A thermometer was fitted on the front die plate, which helped to note the temperature. The 0.3mm of die diameter was selected. The product was collected at the die end and kept at 60 ± 0.5^0 c in an incubator for 3 hrs duration to remove extra moisture from the product. The samples were packed in polythene bags and used for further analysis. Plate 2 shows the preparation of multigrain vermicelli.

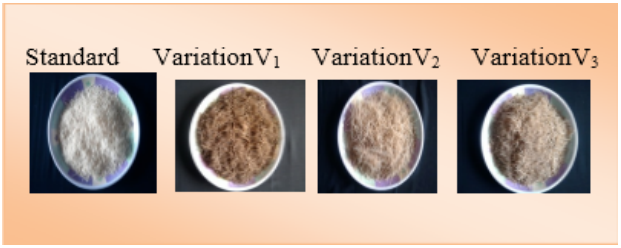

Plate 1: Standard and formulated vermicelli.

Plate 2: Preparation of multigrain vermicelli

2.4 Estimation of physico chemical properties of the multigrain vermicelli

The following physico chemical properties of the vermicelli namely, moisture (AOAC, 1998), bulk density (Stojceska *et al.* 2008), lateral expansion (Ibanoglu *et al.* 2006), water absorption index (Anderson *et al.* 1969), water solubility index Anderson *et al.* (1969) and swelling power (Marrison, 1994) were determined using standard procedure.

2.5 Estimation of nutrient composition and Shelf life analysis of the multigrain vermicelli

The multigrain vermicelli was estimated for proximate nutrient. Namely carbohydrate (Dubojs *et al*. 1956), protein (Lowry's method, 1951), fat (Freeman *et al.*1957) and fiber (Rahghuramalu *et al*. (2003). Energy was computed from protein, carbohydrate and fat. Assessment of microbial content in the multigrain vermicelli was done to find out the total bacterial and yeast mold count (Robert Koch, 1881) on the first day and 30th day after storing in normal room temperature after packing in HDPE and LDPE.

2.6 Standardization of dishes using the multigrain vermicelli

The common south Indian recipe uppuma was prepared and standardized using multigrain vermicelli and standard vermicelli. Sensory evaluation was carried out by panel of 5 semi trained members and score card was used to assess the product. A total of three variation of multigrain vermicelli was developed. The selected ingredients added in each variation were noted for raw ingredients and cooked weight was also recorded. Method involved, equipment used and time taken of each variation were noted. The sensory evaluation was also

conducted for the multigrain vermicelli and the standard by a panel of five experts using a score card.

2.7 Consumer acceptability of the recipe with multigrain vermicelli

Uppuma prepared with all variations of the developed multigrain vermicelli and standard vermicelli was subjected to consumer acceptability with the help of 50 students. They were asked to score products using the score card. The score card is defined by Potter and Hotchkiss, (2002) [15] as an evaluation card, for sample coded with letters or numbers with descriptive terms such as very good, good, fair, poor, very poor. The attributes were scored for a maximum score of 25.

3. Result and Discussion

3.1 Physiochemical properties of the multigrain vermicelli

The physiochemical properties of the multigrain vermicelli were determined and the results are presented in Table 2. The physiochemical and functional property decides the quality of the extruded products. Among the three variations V_3 had less moisture with 3.15 percent. The bulk density of extrudates is important in relation to their ability to float or sink when poured into water and their packaging requirement (Zaidul, 2007) [16]. The bulk density of extruded products varies from 0.520 to 0.479. The moisture content, screw speed and die temperature was found to have significant effect on bulk density of the extruded product (Patil, 1990) [17]. Increase in moisture content may increase the bulk density of the product. It is also found that as the proportions of cereal pulse powder to Maida decreases bulk density increases, the same was noticed in the variation (V_1) with 100% multigrain which had a 3.95 followed by 3.50 in 75 percent added multigrain (V_2). The lateral expansion of extrudates ranged from 66 -100 percent for the developed multigrain variation and 112 percent for the standard vermicelli with 100% of maida. It is observed from the study that increase in percentage of multigrain powder and moisture content, decreased the lateral expansion. The water absorption index of the extrudates varied in the range of 1.205 -1.203/g in the variation (V_1 to V_3) and 1.197 g/g in the standard used.

3.2 Standardization of the multigrain vermicelli

The multigrain vermicelli was prepared in a laboratory and standardized in terms of preparation methods involved, equipment used, cooking quality and time taken and temperature to prepare the selected vermicelli were recorded for standardization of the recipes. It is clear that the cooking time was 10-20 minutes and it was uniform for all the variations including the standard and it's given in Table 3. The quantity of water required was high in the variations V_1, V_2 and V_3 than standard vermicelli.

Table 2: Physiochemical properties of the multigrain vermicelli

Properties	Standard	Multigrain V_1 (100%)	Multigrain V_2 (75%)	Multigrain V_3 (50%)
Moisture (%)	3.1	3.95	3.50	3.15
Bulk density (g/cm)	0.420	0.520	0.479	0.447
Lateral expansion (%)	112	66	88	100
Water absorption index(g/g)	1.197	1.205	1.203	1.202
Water solubility index (%)	0.430	0.256	0.343	0.363
Swelling power (%)	1.245	1.151	1.157	1.168

Table 3: Standardization of the multigrain vermicelli

Name of the Recipe	Raw weight (g)	Cooked weight (g)	Preparation involved	Equipment used	Time taken
Standard vermicelli	50	100	Boiling	Small kadai	10 minutes
Multigrain vermicelli V_1	50	95	Boiling	Small kadai	20 minutes
Multigrain vermicelli V_2	50	105	Boiling	Small kadai	10-15 minutes
Multigrain vermicelli V_3	50	110	boiling	Small kadai	10-20 minutes

3.3 Sensory evaluation and consumer acceptability of the recipes developed with multigrain vermicelli

Selected three recipes were subjected to overall acceptability with the help of five experts using a score card. The result of the overall acceptability of multigrain vermicelli uppuma is presented in Table 4. The overall acceptability of the standard and multigrain vermicelli recipes was found and the results revealed that multigrain vermicelli (V_3 and V_2) were well accepted than the standard. The overall acceptability for multigrain vermicelli uppuma with 100, 50 and 75 percent were 17.6, 22.6, and 22.4 respectively. The uppuma with $V_3$and V_2variations of multigrain vermicelli had higher score than the uppuma prepared with standard vermicelli (18.2). The prepared recipes were subjected to consumer acceptability. The multigrain vermicelli was found to be highly acceptable since all the product had a score of above 20. The score obtained for 100, 50 and 75 percent multigrain vermicelli uppuma were 18.4, 23.2 and 22.2 respectively in V_1, V_2 and V_3.

Table 4: Overall acceptability of multigrain vermicelli uppuma in different variation

Attributes	Standard uppuma	Variation 1 (100%)	Variation 2 (75%)	Variation 3 (50%)
Appearance	3.6	3.6	4.6	4.4
Color	4	3.6	4.6	4.8
Flavor	3.4	3.4	4.8	4
Texture	3.6	3.4	3.8	4.2
Taste	3.6	3.6	4.6	4.4
Overall acceptability	18.2	17.6	22.4	22.6

3.4 Nutrient composition of the developed multigrain vermicelli

The nutrients namely protein, carbohydrate and fat were analyzed and energy was calculated from these nutrients. The results are presented in the Table-5. It is clear from the table that considerable amount of carbohydrate; protein and fat are present in multigrain vermicelli. The multigrain vermicelli V_1 contains 62.8 gm of carbohydrate, 16.5gm of protein, 1.8gm of fat, 0.6gm of fiber and 348 kcal of energy. The multigrain vermicelli V_3 contains 44.7gm of carbohydrate, 17 gm of

protein, 0.92gm of fiber and 1.2gmof fat and 317.6 kcal of energy. V_2 contains 40.8gm of carbohydrate, 0.06gm of fiber, 18.4 gm of protein, 0.6gm of fat and energy 242.2 Kcal/100gm. The protein and fiber content of multigrain vermicelli variations are higher than the standard vermicelli.

3.5 Shelf life of the multigrain vermicelli

Any food before consumption must be analyzed for its microbial quality to check its wholesomeness, the results of total bacterial and yeast and mold count presented in Table 6. The multigrain vermicelli packed in HDPE and LDPE package did not have any colonies formed for bacterial, yeast and mold. The keeping quality was found to be good because it did not deteriorate even on the 30th day of storage. Moisture plays a crucial role in stability of the products and the developed vermicelli had only 3.95 percent to 3.50 percent of moisture and the extended shelf life also indicates the optimum processing conditions used.

Table 5: Nutrient composition of multigrain vermicelli

Products	Carbohydrate (gm)	Protein (gm)	Fat (gm)	Fiber (gm)	Energy (Kcal)
Standard	73.9	11	0.9	0.3	348
Multigrain vermicelli variation$_1$	62.8	16.5	1.8	0.6	317.6
Multigrain vermicelli variation$_2$	40.8	18.4	0.6	0.92	242.2
Multigrain vermicelli variation$_3$	44.7	17	1.2	0.06	257.6

4. Conclusion

It is concluded from the study that the developed multigrain vermicelli V_3 variation had low moisture and optimum bulk density. The water absorption was slightly high and lateral expansion and water solubility index was slightly lower than the commercially available vermicelli. The acceptability was high for 50 percent incorporated multigrain vermicelli. The multigrain vermicelli provided a substantial amount of protein, fiber and carbohydrate. The developed products had an extended shelf life. Hence the developed multigrain vermicelli can be used as an alternate ready to eat breakfast product and thus it can go a long way to improve nutrient quality of the foods consumed by the HIV infected people.

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