Effect of hydrocolloids on cooking quality, protein and starch digestibility of ready-to-cook gluten free extruded product

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Abstract: There is a raising popularity among the consumers for traditional foods due to their health benefits, and pearl millet is one among them. Different types of pearl millet ready-to-cook product (vermicelli) were prepared using pearl millet semolina, defatted soya flour and three different types of hydrocolloids at 2% level and tested against the control (refined wheat flour based) vermicelli. Cooking, sensory quality and nutritional composition including dietary fibre and in vitro digestibility were studied. Though wheat based vermicelli assigned higher overall sensory score (8.2) than all the pearl millet formulations, there was no significant difference ($P<0.05$) between vermicelli with Guar Gum (GG) and Carboxy methyle Cellulose (CMC) and with refined wheat flour. The dietary fiber content of hydrocolloids added pear millet vermicelli was significantly ($P \leq 0.05$) higher than that of refined wheat flour. The addition of hydrocolloids decreased the in vitro digestibility of protein and starch. However the amount of protein (10.2 to 12.7 g/100 g) presented in the soya fortified vermicelli can outweigh the lower protein digestibility. The present product is also suitable to celiac people within general population as a healthy breakfast item. The study demonstrated that incorporation of hydrocolloids not only helped to improve the textural quality of the gluten free formulations but also enhanced the dietary fiber content and lowered the in vitro starch digestibility (IVSD).

Keywords: gluten free, millet, breakfast cereal, in vitro digestibility, dietary fibre

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1 Introduction

Pearl millet (*Pennisetum typhoidam*) is one of the important small millets of tropical and subtropical regions of Asia and Africa. It is a staple food for a large number of people in these areas. Besides supplying calories and proteins in the diet, pearl millet is a good source of essential minerals (Abdalla et al., 1998). However the utilization of this grain like other millets is low and like other millets is mostly used in feed industry. Production of commercially important products such as vermicelli is expected to attract the food industry for its utilization due to the increasing demand for convenience foods like pasta, noodles, vermicelli and naturally healthy and gluten free foods. Though the grain has great nutritional significance it contains certain polyphenolic pigments presented in pericarp, alurone and endosperm regions of the pearl millet seeds imparting undesirable grey colour and tast to its products (McDonough and Rooney, 1989). Studies have been conducted for development of biscuits and cookies (Rathi et al., 2004a), chick pea incorporated pasta (Rathi et al., 2004b), extruded snacks (Filli et al., 2010). Since there were no studies found in the literature on the vermicelli the present study was taken up to investigate the quality of gluten free vermicelli from pearl millet, incorporating defatted soya flour (DSF) and hydrocolloids. Vermicelli is a product prepared by extruding the dough into long strands and dried and is used as a breakfast item in Asia.

2 Materials and methods

Pearl millet was purchased from local market and defatted soya flour was purchased from M.N. Fine

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chemicals Pvt. ltd (Bhopal,India) and the hydrocolloids from Nutriroma (Hyderabad,India). The pearl millet was cleaned and pearledup to 17% using an abrasive dehuller having four stone discs with speed ranging from 1,500-2,000 r min^{-1} and fitted with three HP motors, (Manufactured by Gurunanak Engineering works, Noida,G.B. Nagar,India), and then ground to fine semolina in a pulverizer (Quadrumat Junior semolina mill with a particle size 475 µm which is an universal precision laboratory roller mill for milling grain for subsequent analyses and manufactured by Brebender, Germany).

2.1 Vermicelli preparation

2.1.1 Formulation

They were developed using Pearl millet semolina, DSF with and without hydrocolloids as shown in Table 1. Three types of hydrocolloids were used either alone or in combination to understand their effectiveness on the cooking quality and sensory quality.

Table 1 Pearl millet based Ready-to-Cook gluten free extruded product formulations

Formulations	Composition/%				
	Wheat /Pearl millet semolina (PM)	DSF	Gum Karaya (GK)	Guar Gum (GG)	Carboxy methyl cellulose (CMC)
T0	100	-	-	-	-
T1	77	20	1	1	1
T2	78	20	2	-	-
T3	78	20	-	2	-
T4	76	20	-	2	2
T5	76	20	2	-	2

2.1.2 Production

Initially all the ingredients were mixed and hydrated with the addition of 33% deionised water produced from Millipore R.O system and kept for conditioning for 15 min. The hydrocolloids were dissolved in small amount of water and then added to the flour mixture. The hydrated dough was then kneaded in dough compartment of extruder (Dolly Mini P3, La Monferrina, Italy), for 10 min and extruded into long strands using 1.2 mm die with teflon ring fitted to the pasta machine (Mini P3 model). The extrudate was passed through the die twice to attain uniform texture on the surface of the vermicelli and dried in a tray drier with circulating air at 80°C for 4 h and packed in polythene bags until further analysis.

2.2 Cooking quality

Cooking loss, cooking yield, dry matter, and swelling index were assessed as per the methods described by AACC (2000) approved methods and Tudorica et al. (2002).

2.2.1 Swelling Index

Swelling index of cooked pasta (SI: grams of water per gram of dry pasta) was evaluated by taking a known amount of weight (Tudorica et al., 2002) and then drying vermicelli samples to constant weight at 105°C and expressed as

$$SI = \frac{[\text{Weight of cooked product (W1)} - \text{Weight after drying (W2)}]}{[\text{Weight after drying (W2)}]} \quad (1)$$

2.2.2 Dry Matter

Dry matter was determined according to AACC Standard Method 926.07B. The vermicelli sample of known weight was cooked and then dried in oven at 130ºC for 2 h to determine the dry matter content in the sample.

2.2.3 Cooking loss

Cooking loss in the cooking water collected from each sample was determined by evaporation to constant weight in an air oven at 105°C. The residue was weighed and reported as percentage of the original vermicelli sample.

2.3 Sensory evaluation

The freshly cooked vermicelli was subjected to sensory evaluation using a nine-point hedonic rating scale, where, 9-Like extremely, 8-Like very much, 7-Like moderately, 6-Like slightly, 5-Neither like nor dislike, 4-Dislike slightly, 3-Dislike moderately, 2-Dislike very much, and 1-Dislike extremely. Ten trained experts from department of foods and nutrition evaluated randomly coded vermicelli in terms of colour, appearance, aroma, texture, taste and overall acceptability. Assessors were instructed to cleanse their palate with cold, filtered tap water before tasting each sample. Product characterization was carried out under 'daylight' illumination and through electric lamps in isolated booths.

2.4 Nutritional analysis

The vermicelli was ground to a fine powder in an electrical grinder (Sumeet mixer cum grinder) so as to pass through a 60-mesh sieve (250 μm). The standard methods of AOAC (1990) were employed for analysis of crude protein, crude fat (ether extract) and ash. A factor of 6.25 was applied to convert N into crude protein. Soluble as well as insoluble dietary fibre was analysed by enzymatic gravimetric method (AOAC, 1990) and the total dietary fibre was calculated from soluble and insoluble dietary fibre contents.

2.4.1 In-vitro protein digestibility (IVPD)

In-vitro protein digestibility was estimated by enzymatic method (Akeson and Stahmann, 1965). Samples were homogenized and suspended in 15 mL of 0.1 N HCl containing 1.5 mg of pepsin and incubated at 37°C for 3 h. The suspension was then neutralized with 0.5 N NaOH and treated with 4 mg of pancreatin in 7.5 mL of phosphate buffer (pH 8.0) containing 0.005 M sodium azide. The mixture was gently shaken and incubated at 37°C for 24 h. After incubation, the sample was treated with 10 mL of 10% trichloroacetic acid (TCA) and centrifuged at 3,000 r min^{-1} for 20 min. Protein in the supernatant was estimated by Lowry's method (Raghuramulu et al., 1983) and % IVPD was calculated using the following formula:

$$\%IVPD=\frac{\text{Digested proteins}}{\text{Total proteins}}\times 1 \quad (2)$$

2.4.2 In-vitro-starch digestibility (IVSD)

In vitro starch digestibility was analyzed following the method by Englyst et al. (1992) Amyloglucosidase (1 mL) was added to deionized water (2 mL). Porcine pancreatic alpha-amylase (3.89 g) was dispersed in water (25.7 mL) and centrifuged for 10 min at 2,500 g, and 18.7 mL of supernatant was collected. This supernatant was mixed with 1 mL of diluted amyloglucosidase for making the enzyme solution. The solution was freshly prepared for the digestion analysis. To the sample 5 mL of enzyme solution was added and incubated in a water bath (37°C) with agitation (170 r min^{-1}). Aliquots (0.5 mL) were taken at intervals and mixed with 4 mL of 80% ethanol, and the glucose contents in the mixture were measured using glucose oxidase and peroxidase assay kits and the total starch content was measured according to Englyst et al. (1992).

2.5 Statistical analysis

Experimental results were arranged in blocks of replications and one way ANOVA test was performed using Statgraphics Centurian version 16.1.18. In order to find out the best formulation for ready- to- cook extruded product in terms of cooking quality, sensory quality and the digestibility, Fisher's LSD was performed at 95% confidence level. Pearson's correlation was conducted to understand the correlations among the quality characteristics.

3 Results and discussion

3.1 Cooking quality of extruded product

3.1.1 Swelling index

Swelling Index (SI) of vermicelli is an indicator of the water absorbed by the starch and proteins during cooking, which is utilized for the gelatinization of starch and hydration of proteins. Highest swelling index was observed in T2 and T4 followed by T3 and T5 and the lowest was observed in control, which clearly indicates that addition of hydrocolloids increased the swelling index in general and variation in that was due to the type and combinations used (Table 2). Very high swelling is also undesirable since it leads to softening of the pasta resulting in more cooking loss. In T5 formulation though there was some swelling it was resistant for the leaching by formation of a barrier layer. The same phenomena might not occur if other hydrocolloids are used as in the case of the study conducted by Silva et al (2013) they found that the cooking loss and swelling index of starch noodles prepared with added hydrocolloids were slightly lower than those samples without hydrocolloids. Their results showed that hydrocolloids with high water binding capacity can be used to control the degree of swelling of vegetable particles and starch granules in starch noodle products, and thereby control both dough rheology and textural properties of the cooked noodles.

3.1.2 Dry matter

Highest dry matter was found in control vermicelli however there was no significant difference between the T0 and T4. Among T1, T2 and T3 there was a statistically significant difference (P<0.05) in the dry matter content. The combination and the quantity of hydrocolloids affected the dry matter content. More than the proportion the combination of hydrocolloids influenced the dry matter content which is quite evident from T4 and T5 having the same proportion of hydrocolloids.

Table 2 Mean cooking quality characteristics of Ready-to-Cook gluten free extruded product (vermicelli)*

S.no	Formulations	Swelling index, g of water/g of vermicelli	Dry matter, g/100 g of raw vermicelli	Cooking losses, g/100 g of raw vermicelli	Cooking time/min
1	T0	2.5 ± 0.2^{ac}	90.0 ± 0.3^{a}	5.17 ± 0.1^{a}	7.0 ± 0.2^{a}
2	T1	2.4 ± 0.1^{a}	85.4 ± 0.2^{b}	5.98 ± 0.3	5.0 ± 0.1^{b}
3	T2	2.7 ± 0.5^{b}	86.2 ± 0.2^{c}	5.20 ± 0.5^{cd}	5.3 ± 0.3^{c}
4	T3	2.6 ± 0.4^{bd}	86.0 ± 0.3^{d}	5.23 ± 0.6^{d}	6.0 ± 0.4^{d}
5	T4	2.7 ± 0.3^{b}	89.4 ± 0.5^{e}	$5.19\pm0.4b^{c}$	7.0 ± 0.5^{a}
6	T5	2.6 ± 0.2^{cd}	88.9 ± 0.1^{f}	5.18 ± 0.3^{ab}	7.1 ± 0.6^{a}

Note: Values are mean and SD of six independent determinations; *Values with same superscript in the same column are not significantly different with each other. Significance test performed at 95% confidence level using Fisher's LSD. T0: Wheat semolina (100), T1: PM(80), DSF(20), GK(1), GG(1), CMC(1), T2: PM(78), DSF(20), GK(2), GG(0), CMC(0), T3: PM(78), DSF(20), GK(0), GG(2), CMC(0), T4: PM(76), DSF(20), GK(0), GG(2), CMC(2), T5: PM(76), DSF(20), GK(2), GG(0), CMC(2).

3.1.3 Cooking losses

The cooking losses of all the Pearl millet vermicelli formulations were higher than that of control (T0) and there were no significant differences among the T0, T4 and T5 (Table 2). Highest loss was in T1 followed by T3, T2 and T4. Incorporation of GG and CMC reduced the losses from 5.98 to 5.19 and 5.18 in T4 and T5 which might be due to the formation of strong network there by arresting any leaching of the dry matter from the vermicelli.

3.1.4 Cooking time

Cooking time of vermicelli is an indication of its firmness. More firm vermicelli cooks for a longer time as the penetration of water into the vermicelli is slow than that of less firm product. Highest cooking time was observed in T5 which was due to the synergetic effect of CMC and GG in formation of strong network which increased the cooking time.

3.2 Sensory quality

The mean acceptability scores for sensory attributes of three types of vermicelli are given in Table 3. All the vermicelli formulations were found to be acceptable. Among the various formulations of pearl millet, maximum over all acceptability (8.0) was observed for T4 followed by T5 (7.2) and T3 (7.1). Though wheat based vermicelli received higher score (8.2) than all other pearl millet formulations, there was no significant difference (P<0.05) between T0 and T3 (GG and CMC added) vermicelli. When individual sensory parameters were considered all the scores were less than those of T0 (control) however there was no significant difference between the scores of texture and flavor. The addition of GG and GK when used individually did not improve the texture, but when they are used in combination with CMC there was a significant improvement from 7.2 and 7.1 to 8.4 and 7.4. This can be attributed to the synergetic effect of hydrocolloids compared to GK and CMC combination GG and CMC combination found to be better. It was reported that non starch polysaccharides help to improve the network structure in case of whole wheat pasta (Edwards et al., 1995). When 1.5% of guar gum was added to the pre gelatinized rice flour the texture of rice pasta was improved (Raina et al., 2005). In the present study though the pearl millet is free from gluten which is essential for the structure development, the binding nature of the guar gum has helped to improve the texture by developing firmness. Introduction of guar gum resulted in crumb structure with a more even cell size distribution in gluten free breads (Schwarzlaff et al., 1996).

The colour, flavor and taste of all pearl millet formulations were significantly different from those of T0 which can be attributed to the characteristic grayish color and taste of the grain even though the grain is dehulled to certain extent. In order to augment the flavor and taste of pearl millet formulations addition of ingredients which will mask the flavor might be helpful. The sensory evaluation study established that acceptable vermicelli can be prepared from pearl millet successfully using hydrocolloids on par with traditional vermicelli which is prepared from refined wheat flour.

Table 3 Mean sensory scores of Ready-to-Cook gluten free extruded product (vermicelli)*

Sensory attributes	Formulations						
	T0	T1	T2	T3	T4	T5	CD at 5%
Colour	8.2±0.11^{a}	7.3±02^{b}	7.3±0.02^{b}	7.2±0.02^{c}	7.5±0.02^{b}	7.3±0.02^{b}	0.20
Texture	8.5±0.02^{a}	6.9±0.2^{e}	7.2±0.02^{d}	7.1±0.02^{d}	8.4±0.01^{a}	7.4±0.02^{c}	0.13
Flavor	8.1±0.13^{a}	6.9±0.1^{c}	7.1±0.03^{c}	7.0±0.01^{c}	7.9±0.2^{a}	7.5±0.01^{b}	0.20
Taste	8.1±0.11^{a}	7.1±0.01^{f}	7.3±0.03^{e}	7.2±0.02^{d}	7.9±0.1^{c}	7.6±0.02^{b}	0.12
Overall acceptability	8.2±0.11^{a}	6.9±0.01^{b}	7.0±02^{b}	7.1±0.1^{b}	8.0±0.01^{a}	7.2±0.02^{b}	0.21

Note: *Critical difference at 5% level of significance. Difference between two means exceeding this value was significant. Values with different letters (a–f) differ significantly from each other. T0: Wheat semolina 100), T1: PM(80), DSF(20), GK(1), GG(1), CMC(1), T2: PM(78), DSF(20), GK(2), GG(0), CMC(0), T3: PM(78), DSF(20), GK(0), GG(2), CMC(0), T4: PM(76), DSF(20), GK(0), GG(2), CMC(2), T5: PM(76), DSF(20), GK(2), GG(0), CMC(2).

3.3 Nutrient profile

The nutrient composition of the studied vermicelli is summarized in Table 4. Among the tested formulations of pearl millet vermicelli, the one with defatted soya flour without addition of hydrocolloids was found to be having maximum protein (12.7%) followed by T3 (11.7%) and T4 (10.4%). In pasta prepared from de pigmented pearl millet and chick pea flour and reported that the protein content as 9.42 and 8.7 in pigmented and de pigmented pasta (Rathi et al., 2004b). Combination of DSF and Whey protein concentrate resulted in acceptable quality of instant vermicelli having protein content in the range of 15%-17% (Sudha et al., 2011).

The protein content in the present study was doubled in pearl millet formulations when compared with that of control vermicelli (T0), which can be attributed to the protein content of soya flour and the pearl millet. It was reported that pearl millet nutritive value, especially protein, fat and mineral contents is comparable or even superior to those of other cereal food grains (Abdalla et al.,1998; Rathi et al., 2004b; Hadimani et al., 1995). In order to achieve higher protein content without affecting other sensory characteristics, addition of soya is a better choice.

Table 4 Mean Nutrient content of Ready-to-Cook gluten free extruded product (vermicelli)

Nutrient	Formulations						
	T0	T1	T2	T3	T4	T5	F Ratio
Protein, g	5.1±0.1^{a}	12.70±0.02^{b}	11.9±0.2^{c}	14.7±0.2^{d}	14.9±0.11^{d}	14.2±0.03^{f}	1.73*
Fat, g	4.10±0.01^{a}	4.0±0.02^{a}	3.9±0.21^{a}	3.8±0.1^{d}	3.7±0.12^{d}	3.6±0.12^{d}	1.06*
Ash, g	1.06± 0.02^{a}	1.96±0.01^{b}	1.89±0.1^{c}	1.82±0.11^{d}	1.79±0.13^{e}	1.78±0.21^{e}	1.02*
SDF, g	0.5±0.01^{a}	3.3±0.02^{b}	3.9±0.12^{c}	4.7±0.1^{d}	5.9±0.12^{e}	5.0±0.11^{f}	4.3*
IDF, g	1.5±0.012^{a}	11.7±0.03^{b}	11.6±0.12^{c}	11.4 0.12^{d}	11.0±0.11^{e}	11.5±0.11^{f}	6.28*
TDF, g	2.0±0.13^{a}	15.0±0.012^{b}	15.5±0.13^{c}	16.1±0.13^{d}	16.9±0.13^{e}	16.5±0.12^{f}	5.28*
Iron, mg	3.41±0.12^{a}	11.8± 0.05^{b}	11.5±0.12^{c}	11.4±0.13^{d}	11.3±0.13^{e}	11.5±0.12^{c}	2.07*
Zinc, mg	1.31±0.12^{a}	2.82±0.02^{b}	2.78±0.13^{c}	2.75±0.11^{d}	2.77±0.13^{e}	2.79±0.13^{f}	2.2*
Calcium, mg	38.4±0.03^{a}	43.6±0.01^{b}	42.0±0.12^{c}	42.5±0.12^{d}	41.9±0.13^{e}	39.9±0.14^{f}	2.2*
Moisture, mg	9.5±0.02^{a}	10.0±0.01^{b}	11.1±0.12^{c}	11.0±0.12^{c}	12.1±0.12^{e}	11.9±0.12^{f}	2.2*
Carbohydrates, g	78.0±0.02^{a}	80.0±0.01^{b}	76.0±0.^{3c}	75.0±0.11^{d}	74.2±011.^{e}	74.5±0.12^{e}	2.1*

Note: Results are mean ± SD same superscripts within the row are not significantly different with each other at $P<0.05$; * Significant ($P<0.05$)SDF-Soluble dietary fibre, IDF-Insoluble dietary fibre, TDF-Total Dietary fibre, PT0: Wheat semolina (100), T1: PM(80), DSF(20), GK(1), GG(1), CMC(1), T2: PM(78), DSF(20), GK(2), GG(0), CMC(0), T3: PM(78), DSF(20), GK(0), GG(2), CMC(0), T4: PM(76), DSF(20), GK(0), GG(2), CMC(2), T5 PM(76), DSF(20), GK(2), GG(0), CMC(2).

The fat content ranged from 3.6 (T5) to 4.1 (T0, control). There was slight reduction in the fat content upon addition of hydrocolloids in all the formulations. With respect to the dietary fibre the vermicelli made out of pearl millet, defatted soya flour and combination of hydrocolloids (4%) has highest dietary fibre (16.9%) whereas it is only 2% in control vermicelli. The addition of 2% of GK and GG to pearl millet vermicelli enhanced the TDF from 15% to 15.5% (T2) and 16.1% (T3) and then addition of CMC at 2% along with 2%

GK and GG further enhanced to 16.9% (T4) and 16.5% (T5). Consumption of 50 g of this vermicelli provides approximately ¼ of the recommended dietary allowance of dietary fibre as per ICMR (Indian Council of Medical Research). The increase in the total dietary fibre is mainly due to the increase in the soluble fibre component than the insoluble component. Rathi et al. (2004b) reported dietary fibre content in native and de pigmented pearl millet pasta as 11.5% and 11.0% respectively.

3.3.1 Effect of formulation on IVPD and IVSD of extruded product

In vitro protein digestibility of wheat vermicelli was 90 and among the pearl millet based vermicelli highest digestibility was in T1 followed by T2, T3, T5 and F4. There was a significant difference in the digestibility of protein (p<0.05) but no difference between T1 and T2, T4 and T5. Plant hydrocolloids used in the food industry to improve texture and stability of food can reduce protein digestibility and, consequently, modify the bioavailability of amino acids (Mouécoucou et al., 2003). However one needs to balance the protein and dietary fibre content (Table 5).

Table 5 Effect of type of grain and hydrocolloids on in vitro protein (%) and starch (mg maltose released/g) digestibility of different vermicelli (on dry matter basis)*

In vitro digestibility	Vermicelli formulations					
	T0	T1	T2	T3	T4	T5
IVPD	90 ± 0.7^{C}	73 ± 0.55^{A}	72 ± 0.35^{A}	71 ± 0.67^{D}	69 ± 86^{B}	69.5 ± 78^{B}
IVSD	45 ± 0.9^{A}	39 ± 0.45^{B}	35 ± 0.88^{C}	36 ± 0.87^{C}	32 ± 78^{E}	31 ± 0.59^{E}

Note: *Values with same superscripts in the same column are not significantly different (P<0.05). T0: Wheat semolina (100), T1: PM(80), DSF(20), GK(1), GG(1), CMC(1), T2: PM(78), DSF(20), GK(2), GG(0), CMC(0), T3: PM(78), DSF(20), GK(0), GG(2), CMC(0), T4: PM(76), DSF(20), GK(0), GG(2), CMC(2), T5: PM(76), DSF(20), GK(2), GG(0), CMC(2).

The starch digestibility of the vermicelli was 45 starch (mg maltose released/g) in wheat vermicelli. The addition hydrocolloids to pearl millet vermicelli reduced the starch digestibility; and higher reduction was seen in higher hydrocolloid containing vermicelli. The percent digestibility ranged from 31 starch (mg maltose released/g) in T5 to 39 starch (mg maltose released/g) in T1 vermicelli (Table 5). The effect of hydrocolloids on the starch hydrolysis was greatly dependent on the starch origin. It was reported that Guar gum when combined with potato starch decreased the enzymatic hydrolysis and glycemic index of this starch (Gularte and Rosell, 2011; Mouécoucou et al., 2003). In the presence of guar gum, the starch hydrolysis was reduced by nearly 25% during the first 10 min and by 15% at the end of in vitro intestinal digestion (Anne Dartois et al., 2010).

3.4 Correlation among the quality characteristics

The Pearson's correlation matrix showed that with the increasing dry matter there was a significant (P=0.5) increase in the cooking time and a decrease in Cooking losses and IVPD. Swelling index and cooking losses were negatively correlated with IVSD and IVPD and cooking time respectively. With the increasing IVPD there was an increase in the IVSD (Figure 1).

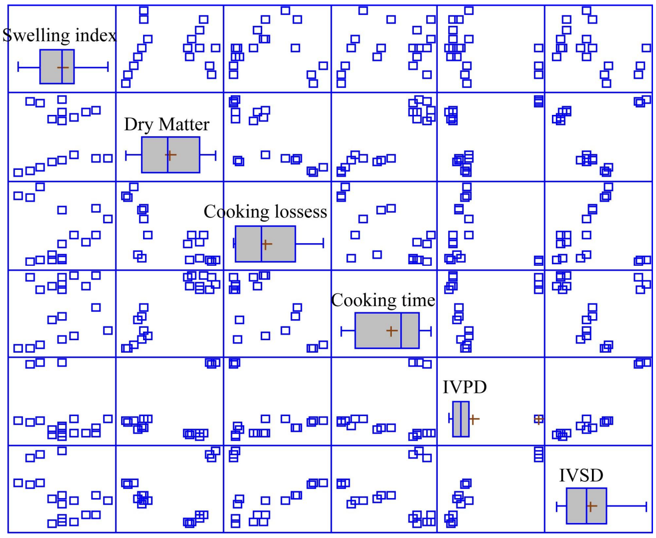

Figure 1 Correlation matrix of the different quality parameters of the vermicelli

4 Conclusions

The addition of guar gum and karaya gum in combination with carboxy methyl cellulose made possible the production of gluten free ready–to-cook product (vermicelli). The addition of hydrocolloids decreased in vitro digestibility of protein and starch. However the amount of protein presented in the soy fortified vermicelli can outweigh the lower protein digestibility. The study demonstrated that the vermicelli can be successfully prepared from pearl millet with good amount of protein, minerals, soluble and insoluble fibre which can be promoted as functional product with multi advantages.

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