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Quality evaluation of dosa from millet flour blend incorporated composite flour

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ABSTRACT

The present investigation was done to prepare dosa using composite flour containing kodo and barnyard millet flour, whole wheat flour and defatted soy flour of four different combinations and to study the impact of millet flour blend incorporation on characteristics of dosa. The prepared dosa was characterized by analyzing physical properties, nutritional properties, organoleptic characteristics and in vivo glycemic load among ten normal and ten type 2 diabetic subjects. Results indicated that the diameter of dosa was increased with decrease in thickness; the spread ratio was increased significantly at $p<0.001$; and the weight of batter and dosa were decreased while increasing the incorporation of millet flour blend. The total carbohydrate, starch, and total sugar content were decreased; protein, amylose/amylopectin ratio and crude fiber content were increased significantly while increasing the incorporation of millet flour blend. As the millet flour blend ratio increased above 20%, most of liking and Just About Right (JAR) attributes especially on texture of dosa was decreased marginally. Organoleptically 30% level of incorporation was accepted. The glycemic index and glycemic load were decreased significantly while increasing the incorporation of millet flour blend. Thus the consumption of prepared dosa from composite flour will definitely pose a light to increase the nutritional security and decrease the incidence of double disease burden.

Introduction

The nutritive value of millet is comparable to other staple cereals like wheat and rice, some of them are even better with regard to average protein, fat and mineral contents (Gopalan et al, 2007). Sorghum and millets are rich in starch content (56 to 73% in sorghum and 63-71% in pearl millet). The millets are rich in iron and phosphorus and pearl millet in ash content. The whole grains are rich in B-complex vitamins while deficient in vitamin A and C. These cereals can act as a shield against nutritional deficiency disorders and provide for nutritional security (Seetharama and Rao, 2004).

Millets are generally consumed directly. Rotis (unleavened bread) are made from flour, thin or thick porridges from grits, and cooked rice from whole sorghum, pearl millet and finger millet. Kodo, foxtail, little, proso and barnyard millets are cooked like rice and consumed (Liu, 2003).

Cereal grains, including soft wheat flour, are low in protein (7 to 14%) and are deficient in some amino acids such as lysine and certain other amino acids (Claughton and Pearce, 1989). Legumes on the other hand, are higher in proteins (18 to 24%) than cereal grains and can be used to support certain amino acids such as lysine, tryptophan, or methionine (Rababah et al, 2006). Soy protein is preferred because of its low cost, accessibility, widely varying functional properties and high content of good quality protein. While soy protein is rich in lysine, cereals are rich in sulphur containing amino acids, especially methionine and hence blending of these two in appropriate quantities will make up the individual deficiencies (Prasad et al, 2007).

Value addition through processing of nutritious cereals should also be explored and popularized to make them popular among consumers. Some of the broad steps in making them popular are a large scale awareness campaign about it and moreover the barrier of low social status attached to these nutritious cereals should be removed by terming them as health foods (Seetharama and Rao, 2004).

Hence the present study was done to expand the utility of kodo *(Paspalum Scrobiculatum)* and barnyard *(Echinochloa Colona)* millet by incorporating it in to whole wheat flour and defatted soy flour mixture and to study the impact of millet flour blend incorporation on characteristics of dosa.

Methodology

Among the cultivated varieties, popular varieties of CO3 of kodo millet *(Paspalum scrobiculatum)* and CO1 of barnyard millet *(Echinochloa colona)* were procured from the local market in Salem District, Tamil Nadu. The raw grain of kodo and barnyard millet were cleaned, winnowed and soaked in cold water for 24 hours. This was steamed for 20 minutes and shade dried to moisture content of 10-12 g% and further milled into flour. The flour prepared from suitable preconditioning of kodo and barnyard millet were mixed in equal proportion and sieved through 40 mesh sieve.

Development of composite flour (CF)

Composite flour technology initially referred to the process of mixing wheat flour with other cereal and legume flours for making bread and biscuits. However the term can also be used in regard to mixing of non wheat flours, roots and tubers, legumes or other raw materials (Dendy and Dobraszczyk, 2001a).

The prepared millet flour blend was mixed with branded whole wheat flour and defatted soya flour available in the market in four combinations (Table 1).

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Characterization of dosa

The dosa was prepared from whole wheat flour and composite flour of different combinations and studied for its physical, cooking, nutritional, sensory characteristics and *in vivo* glycemic response. The determined physical and cooking characteristics were diameter (cm), thickness (cm), spread ratio (AACC method, 2000), weight (g) and volume of batter (ml), weight of cooked dosa (g), per cent loss of weight on cooking (formula of Arora and Rajni, 2006) and cooking time (min).

The nutritional parameters included the determination of moisture and ash content by AOAC method (Ranganna, 2004), total carbohydrate and starch by anthrone method; total dietary fiber by acid-alkali digestion method; total sugar and reducing sugar by dinitro salicylic acid method; amylose and amylopectin by colorimetric method; protein content by kjeldhal method and fat by soxhlet method (Sadasivam and Manickam, 2005).

Sensory characteristics of cooked dosa were assessed by descriptive sensory analysis and sensory acceptability level. The descriptive sensory profile on color, starchy mouth coating, grainy nature, cohesiveness and softness were studied through an attribute scale (5 point scale) designed by the investigator. The sensory acceptability of developed dosa was determined by a 5 point hedonic scale ranging from 1 indicates dislike very much to 5 indicates like very much with a neutral category of 3 indicating neither like nor dislike for parameters like appearance, color, flavor, texture and taste. The dosa were considered acceptable (overall) if their mean total score was about and more than 11. Sensory evaluation was conducted by the method suggested by Bhat and Sharma (1989).

In vivo glycemic response

Ten normal healthy adult women aged between 35-50 years whose BMI within 20-25 kg/m^2 and fasting blood sugar level within 70-110 g/dl and ten confirmed type 2 diabetic women aged 40-55 years whose BMI within 20-30 kg/m^2 and fasting blood sugar level within 140-180 g/dl were selected for testing the glycemic responses of the developed dosa. Ethical clearance was obtained for this part of the study from the local institutional ethical committee at Sri Gokulam Hospital, Salem, TamilNadu where the determination of glycemic index was carried out.

On the first visit, the selected women were subjected to an oral glucose tolerance test using 50g glucose load. On subsequent visits, the selected women were given a test food and one on each day containing 50g (available) carbohydrate which was consumed over 10-15 minutes time period. At the time of intervention that is just 12 hours before the test, selected type 2 diabetic women were instructed to withdraw the consumption of oral hypoglycemic drugs to avoid the influence of drugs on blood glucose. Blood glucose response from capillary blood sample at 0 h, 1h, 2h and 3h were obtained after administering standard and test meal. The blood glucose level was measured using Accuchek glucometer using glucostik which is based on the action of glucose oxidase and recorded. Throughout the collection of blood samples, the subjects were not allowed to eat/drink any calorie containing foods (Urooj et al, 2006).

Incremental Area Under the Curve (IAUC) was calculated by graphic plotting of blood glucose values on y-axis and time on x-axis and computed by the trapezoidal rule as follows.

$$\mathrm{AUC} = \frac{1}{2}\sum_{i\text{-}1}^{n-1}\left(T_{i+1} - T_i\right)\left(\mathrm{C}_{i+1} + C_i - 2B\right)$$

Where T_i is the ith time value. C_i is the ith concentration value, n is the number of time values, and B is the baseline value. The area between the baseline and the curve is computed by this formula. The AUC should be calculated from zero to a time at which the concentration has returned to its regular levels. Glycemic index and load was calculated as

$$\text{Glycemic index} = \frac{\text{IAUC of test food}}{\text{IAUC of glucose}} \times 100$$

$$\text{Glycemic load} = \frac{\text{Grams of carbohydrate per serving * GI}}{100}$$

Statistical analysis

The determined data were fit to a ANOVA based Critical Difference to determine the influence of incorporation of millet flour blend on quality characteristics of dosa and Tukey HSD (Honestly Significant Difference) test was done to determine the significant difference in descriptive sensory scores of dosa from composite flour of different combinations and with rice dosa as control.

Results and discussion

Idli and dosa are common foods in south India. As these traditional foods occupy a very important place in Indian dietary, upgradation of nutritional quality by supplementing it with high quality protein from less expensive sources will result in much greater health potential (Dendy and Dobraszczyk, 2001b; Tripathy et al, 2003).

Physical and cooking characteristics of dosa

The physical and cooking characteristics of dosa (Table 2) reveal that the diameter of dosa was increased with decrease in thickness which was not significant ($p>0.05$) resulting in increased spread ratio while increasing the level of millet flour blend in composite flour. The spread ratio of the dosa from standard composite flour was significantly ($p<0.001$) greater than spread ratio of dosa from rice flour and millet flour blend incorporated composite flour.

The weight of the batter and dosa were decreased gradually and it was noted that the weight of batter and dosa from 30% millet flour blend incorporated composite flour was significantly ($p<0.05$) less than standard composite flour. This may be due to less hydration rate of composite flour with millet flour blend than standard composite flour.

The per cent loss of weight on cooking varied between 23 and 29 % and the per cent weight loss on cooking of dosa from millet flour blend incorporated composite flour (28-29%) was significantly ($p<0.001$) greater than rice batter (23.4%) and standard composite flour (22.8%).

The cooking time for one dosa from 60-70 g batter was varied between 1.30 minutes and 1.45 minutes. The cooking time for dosa from composite flour was 10 to 15 seconds higher than rice dosa. But it was not significant ($p>0.05$).

Nutritional composition of dosa

The nutrient content of dosa from rice and from composite flour was determined in duplicates and the mean values are presented in table 3.

The moisture content of dosa on wet basis was varied between 18.3 g % and 19.2 g %. The protein, fiber, amylose/amylopectin ratio of dosa were found to be increased significantly ($p<0.05$) with increase in millet flour blend level from 10 % to 30 %. Whereas, the total carbohydrate, total sugar and starch content were decreased significantly ($p<0.01$) while increasing the level of millet flour blend. The protein content of dosa from standard composite flour was significantly ($p<0.001$) higher than dosa from rice and black gram dhal combination which revealed the influence of defatted soy flour.

Tripathy et al (2003) reported that with the incorporation of whey protein concentrate, an increase in protein, fat, total ash, calcium and phosphorus contents and decrease in carbohydrate, crude fiber and iron contents of ragi dosa were observed. The protein content ranged from 11.2 to 14.8 g / 100 g.

Sensory characteristics of dosa

Sensory evaluation of eating quality is a direct and ultimate method for evaluating the final product (Oberoi, 2007).

Descriptive sensory attributes of dosa

The results of intensity scores on various sensory attributes are presented in table 4.

The dosa become darker significantly while increasing the level of millet flour blend incorporation. The darkness of the color may be due to the presence of tannin in millet flour blend and also might be due to high protein contents which resulted in Maillard reaction. The starchy mouth coating nature was mild in dosa from 30% MBCF. This suggests that the millet flour may mix with saliva to form starchy pasty slurry that coats mouth surfaces during mastication.

The dosa from 30% MBCF was found to have significantly ($p<0.05$) higher grainy texture than dosa from other composite flour and rice flour. This was probably due to the persistence of the particulate form of the millet flour blend.

The dosa from 30% MBCF was less cohesive than dosa from other composite flour and rice flour. Since the cohesiveness is reduced with increase in millet flour blend, the dosa gets disintegrated before being removed from the pan. The softness of dosa from composite flour was marginally less in comparison with softness of dosa from rice flour. The softness of dosa from 30% MBCF was just about right and others in most of liking score on softness.

Tripathy et al (2003) reported that ragi dosa and ragi malt were best accepted at 30% blend of Whey Protein Concentrate (WPC) with mean scores for overall acceptability being 4.1 and 3.9 respectively. Ragi dosa at 30% level of WPC had a better sensory profile than control.

Sensory acceptability of dosa

The mean organoleptic score of dosa from composite flour in table 5 reveals that there was a marginal increase in total overall score of dosa while increasing the level of millet flour blend. The mean total score of dosa from composite flour varied between 19.40 and 23.20 which was significantly ($p<0.05$) higher from mean total score of rice dosa. It is also noted that the mean overall score of dosa from composite flour was in the highly acceptable range (20-25).

As per the Tukey HSD homogenous subsets, rice dosa, dosa from standard composite flour and 10% millet flour blend incorporated composite flour did not differ significantly.

Glycemic index and load of dosa

The mean glycemic response, Glycemic Index (GI) and Glycemic Load (GL) of rice dosa, dosa from standard composite flour and dosa from 30% millet flour blend incorporated composite flour (Table VI) reveal that (as per the Tukey HSD test for comparing means), the mean initial blood glucose level for each meal tested in ten normal adult women and type 2 diabetic women was not significantly different. The overall glycemic response at each time interval was higher for rice dosa than dosa from composite flour. The mean glycemic index and load of dosa from standard composite flour was significantly lower than the respective branded products and mean glycemic index and load of dosa from 30% millet flour blend incorporated composite flour was further significantly lower than rice dosa and dosa from standard composite flour. This reveal that the incorporation of both defatted soy flour and millet flour blend had significant influence of GI and GL.

A similar conclusion was given by Thakkar and Kapoor (2007) who reported that the finger millet preparations have lower GI values than rice preparations. Shukla et al (1991) revealed that millets evoke lower glycemic response than other cereals.

The results on paired sample 't' test revealed no significant difference in both the glycemic index and glycemic load of developed dosa between normal and type 2 diabetic women.

Correlation between characteristics of developed dosa

Bivariate analysis (Pearson correlation coefficients) on dataset of characteristics of dosa in table 7 reveals that the grainy nature of dosa inversely significantly ($p<0.05$) affect cohesiveness and softness of dosa. The cohesiveness was directly correlated ($p<0.05$) with softness and fiber content and inversely significantly ($p<0.05$) correlated with amylose content.

The softness of dosa was directly correlated ($p<0.05$) with protein, ash and fat content and inversely significantly ($p<0.05$) correlated with total carbohydrate, total sugar and non-reducing sugar content.

Conclusion

The quality attributes of developed dosa was altered significantly, while increasing the level of millet flour blend. The incorporation of millet flour blend and soy flour improved the quality of dosa in terms of nutrient density, glycemic response, and taste. But the grainy appearance with brown color was not appealing to the consumer. The 30% millet flour blend incorporated composite flour (MBCF) based dosa was highly acceptable. Hence the millet flour blend and defatted soy flour incorporation has potential as an ingredient in novel products targeting health conscious consumers who associate darker colored cereal based foods with superior nutritional composition.

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Table 1: Composite flour of different combinations

Millet flour blend %	Whole wheat flour %	Defatted soya flour %
-	90	10
10	80	10
20	70	10
30	60	10

Table 2: Physical and cooking characteristics of dosa from composite flour

Characteristics	HMRD	SD	10% MBD	20% MBD	30% MBD	CD
Diameter(cm)	10.63±0.4	12.28±0.26	11.23±0.31	11.27±0.33	11.58±0.4	1.16[a] 0.83[b] 0.59[c]
Thickness(cm)	0.64±0.06	0.37±0.01	0.44±0.03	0.41±0.23	0.4±0.1	0.118[a] 0.084[b] 0.061[c]
Spread ratio	16.61±1.47	33.21±1.3	25.46±2.4	27.7±0.9	29.4±2.4	5.89[a] 4.20[b] 3.01[c]
Weight of batter / dosa	62.5±5.0	70.0±3.5	63.3±2.9	60.67±1.2	60.0±5.0	13.33[a] 9.51[b] 6.82[c]
Volume of batter / dosa	51.25±2.5	51.0±2.24	51.67±2.9	50.0±0.0	50.0±0.0	7.12[a] 5.08[b] 3.64[c]
Weight of one dosa	47.75±5.2	54.0±4.2	45.0±0.0	43.7±4.7	43.3±4.2	14.5[a] 10.35[b] 7.42[c]
% loss of weight on cooking	23.39±8.97	22.8±5.54	28.85±3.3	28.1±6.4	27.8±2.0	2.85[a] 1.49[b] 1.07[c]
Cooking time (min)	1.30±0.02	1.45±0.04	1.40±0.02	1.40±0.05	1.45±0.03	

HMRD – Home Made Rice Dosa, SD – Dosa from Standard Composite flour, 10% MBD – Dosa from 10% Millet flour blend incorporated composite flour, 20% MBD – Dosa from 20% Millet flour blend incorporated composite flour, 30% MBD – Dosa from 30% Millet flour blend incorporated composite flour; values in the table are the average of three determinants; CD – Critical Difference; a - significant at $p<0.001$, b - significant at $p<0.01$, c - significant at $p<0.05$.

Table 3: Nutritional composition of dosa from composite flour

Nutrients (g%)	HMRD	SD	10% MBD	20% MBD	30% MBD	CD
Moisture	19.0±0.57	18.3±0.28	19.2±0.14	18.9±0.14	19.1±2.08	2.08^{a} 1.22^{b} 0.78^{c}
Total carbohydrate	63.5±0.14	52.0±2.82	49.0±1.41	46.0±1.41	44.0±2.82	13.7^{a} 8.1^{b} 5.1^{c}
Protein	3.2±0.14	6.6±0.14	7.2±0.14	8.2±0.28	9.1±0.14	1.23^{a} 0.72^{b} 0.46^{c}
Fiber	2.8±0.28	2.5±0.28	3.8±0.14	4.3±0.42	4.7±0.28	2.04^{a} 1.20^{b} 0.76^{c}
Ash	2.0±0.14	2.2±0.14	2.1±0.28	2.2±0.14	2.4±0.28	1.63^{a} 0.95^{b} 0.61^{c}
Fat	8.7±0.28	9.3±0.28	9.5±0.14	9.6±0.14	9.8±0.14	1.44^{a} 0.85^{b} 0.54^{c}
Total sugar	6.0±0.14	4.4±0.14	3.9±0.14	3.7±0.28	3.2±1.14	1.23^{a} 0.72^{b} 0.46^{c}
Reducing Sugar	1.7±0.14	1.2±0.28	0.89±0.01	0.8±0.14	0.76±0.28	1.07^{a} 0.63^{b} 0.40^{c}
Non-Reducing sugar	4.3±0.28	3.2±0.42	3.01±0.15	2.9±0.42	2.6±0.11	2.12^{a} 1.25^{b} 0.79^{c}
Starch	51.5±0.14	41.2±0.28	38.1±0.14	37.2±0.14	36±0.28	1.44^{a} 0.85^{b} 0.54^{c}
Amylose	13.1±0.14	12.8±0.14	12.0±0.14	11.9±0.28	11.7±0.42	1.74^{a} 1.02^{b} 0.65^{c}
Amylopectin	38.4±0.14	28.4±0.42	26.1±0.14	25.3±0.28	24.3±0.14	1.74^{a} 1.02^{b} 0.65^{c}
Amylose/ amylopectin ratio	0.341±0.004	0.450±0.001	0.459±0.002	0.470±0.005	0.481±0.014	0.05^{a} 0.03^{b} 0.02^{c}

HMRD – Home Made Rice Dosa, SD – Dosa from Standard Composite flour, 10% MBD – Dosa from 10% Millet flour blend incorporated composite flour, 20% MBD – Dosa from 20% Millet flour blend incorporated composite flour, 30% MBD – Dosa from 30% Millet flour blend incorporated composite flour; values in the table are the average of two determinants; CD – Critical Difference; a - significant at $p<0.001$, b - significant at $p<0.01$, c - significant at $p<0.05$.

Table 4: Mean descriptive sensory attributes score of dosa from composite flour

Sensory Attributes	HMRD (a)	SD (b)	10% MBD(c)	20% MBD (d)	30% MBD (e)	Tukey HSD Homogenous subsets
Color	$1.0±0.0^{bcde}$	$2.0±0.0^{acde}$	$3.0±0.0^{abce}$	$3.55±0.5^{abce}$	$4.0±0.0^{abcd}$	-
Starchy Mouth coating	$1.0±0.0^{e}$	$1.0±0.0^{e}$	$1.0±0.0^{e}$	$1.05±0.2^{e}$	$1.85±0.4^{abcd}$	a,b,c&d
Grainy	$5.0±0.0^{de}$	$5.0±0.0^{dc}$	$5.0±0.0^{de}$	$4.0±0.0^{abce}$	$3.40±0.5^{abcd}$	a,b,&c
Cohesiveness	$1.3±0.5^{cde}$	$1.0±0.0^{cde}$	$2.0±0.0^{abde}$	$2.6±0.5^{abce}$	$3.15±0.4^{abcd}$	a&b
Softness	$1.45±0.5^{bcde}$	$2.0±0.0^{ade}$	$2.0±0.0^{ade}$	$2.60±0.5^{abce}$	$3.0±0.0^{abcd}$	b&c

The letter a, b, c, d and e in the superscript indicates the significant difference of mean with the mean of other columns; HMRD – Home Made Rice Dosa, SD – Dosa from Standard Composite flour, 10% MBD – Dosa from 10% Millet flour blend incorporated composite flour, 20% MBD – Dosa from 20% Millet flour blend incorporated composite flour, 30% MBD – Dosa from 30% Millet flour blend incorporated composite flour; values in the table are the average of twenty determinants.

Table 5: Mean sensory acceptability score of dosa from composite flour

Criteria	HMRD	SD	10% MBD	20% MBD	30% MBD
Appearance	4.2±0.788	4.1±0.567	3.8±0.421	3.9±0.567	4.9±0.366
Color	3.5±0.849	4.1±0.316	4±0.666	3.7±0.483	4.3±0.674
Taste	4.1±0.737	3.9±0.316	4.5±0.527	4.4±0.699	4.6±0.516
Texture	4.1±0.737	4.0±0.0	3.7±0.823	4.7±0.483	4.6±0.516
Flavour	3.2±0.788	3.3±0.674	4.6±0.516	4.8±0.421	4.8±0.421
Total	19.1±3.48	$19.4±0.843^{NS}$	$20.6±1.955^{NS}$	$21.5±1.178^{**}$	$23.2±1.475^{**}$

HMRD – Home Made Rice Dosa, SD – Dosa from Standard Composite flour, 10% MBD – Dosa from 10% Millet flour blend incorporated composite flour, 20% MBD – Dosa from 20% Millet flour blend incorporated composite flour, 30% MBD – Dosa from 30% Millet flour blend incorporated composite flour; values in the table are the average of twenty determinants; NS – Not Significant; ** - Significant at $p<0.05$.

Table 6: Mean glycemic response, glycemic index and load of developed dosa

Meals	Mean blood glucose concentration mg/d l				Area under curve	Glycemic index	Glycemic load
	0 hour	1 hour	2 hour	3 hour			
Normal subjects (n=10)							
Glucose	93.4±6.11	159.4±5.77	123.5±4.5	96.5±5.8	377.8±13.05	100.0±0.0	50.0±0.0
Rice Dosa (a_3)	93.4±4.71	146.1±5.87	125.7±3.74	99.3±7.22	368±10.72	97.55±4.80 ^{b_3c_3}	61.9±3.0 ^{b_3c_3}
Standard Dosa (b_3)	91.4±4.83	133.1±4.40	116.8±3.22	94.9±5.54	343±9.31	90.87±3.72 ^{a_3c_3}	47.3±1.9 ^{a_3c_3}
30% Dosa (c_3)	89.7±5.69	120.9±3.81	104.3±2.00	93.1±4.79	316.6±7.32	83.87±3.33 ^{a_3b_3}	36.9±1.5 ^{a_3b_3}
Type 2 diabetic subjects (n=10)							
Glucose	160.8±12.4	286.2±29.2	255.4±24.0	231.4±18.4	737.7±62.3	100.0±0.0	50.0±0.0
Rice Dosa (a_3)	160.6±7.4	215.8±15	237.7±10.3	210.4±15.8	690.1±26.8	94.0±7.7 ^{b_3c_3}	59.7±4.9 ^{b_3c_3}
Standard Dosa (b_3)	159.5±5.4	245.7±17.2	221.1±10.7	200.8±16.3	648.7±29.1	88.4±7.5 ^{a_3c_3}	46.0±3.9 ^{a_3c_3}
30% Dosa (c_3)	154.7±8.5	227.8±12	209.3±8.21	190.1±11.5	611.1±23.1	83.3±7.7 ^{a_3b_3}	36.7±3.4 ^{a_3b_3}

The letter a,b,c in the superscript indicates the significant difference of mean with the mean of other columns at $p<0.05$.

Table 7: Bivariate correlation matrix on characteristics of developed dosa

Criteria	Spread ratio	Grainy	Cohesiveness	Softness
Spread ratio	1.0			
Grainy	-0.320	1.0		
Cohesiveness	0.193	-0.912(*)	1.0	
Softness	0.610	-0.927(*)	0.881(*)	1.0
Moisture	-0.541	-0.305	0.603	0.171
Total carbohydrate	-0.742	0.699	-0.761	-0.911(*)
Protein	0.754	-0.734	0.771	0.933(*)
Fiber	0.185	-0.856	0.991(**)	0.852
Ash	0.723	-0.844	0.702	0.929(*)
Fat	0.723	-0.713	0.781	0.916(*)
Total sugar	-0.738	0.691	-0.761	-0.904(*)
Reducing sugar	-0.657	0.657	-0.780	-0.869
Non reducing sugar	-0.791	0.654	-0.707	-0.887(*)
Starch	-0.761	0.604	-0.696	-0.851
Amylose	-0.426	0.747	-0.912(*)	-0.870
Amylopectin	-0.788	0.582	-0.665	-0.839
Amylose/Amylopectin	0.841	-0.565	0.617	0.832
** Correlation is significant at the 0.01 level (2-tailed).				
* Correlation is significant at the 0.05 level (2-tailed).				