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Development and nutritional evaluation of value added extruded products from maize-oat-*tulsi* flour blend

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Abstract
The study was conducted on Maize (QPM mixture), Oat (HJ-8) and *Tulsi* leaves. Six types of blend flours *i.e* Type-I, Type-II and Type-III blend flour were prepared from maize: oat in ratios of 85:15, 70:30, 55:45(W/W), Type-IV, Type-V and Type-VI blend flours were prepared from maize: oat: *tulsi* leaves in ratio of 80:15:5, 65:30:5, 50:45:5 (W/W). Different types of extruded products prepared using blend flours were developed and assessed organoleptically. Most acceptable products were nutritionally analyzed. Results revealed that different extruded products based on blend flours were *i.e* Pasta, vermicelli and macroni. On the basis of organoleptic evaluation, it was found that pasta, vermicelli and macroni developed from Type II and Type V blend flours were most acceptable. Value added products prepared from *tulsi* leaves supplemented blend flour Type-V had significantly higher content of crude fiber, ash as compared to unsupplemented and controls. Nutritional composition of pasta, macaroni and vermicelli revealed that significantly higher crude protein content was 9.48%, 9.38% and 10.41% observed in Type-II pasta, macaroni and vermicelli while, crude fibre content were significantly higher in Type-V pasta, vermicelli and macaroni. Therefore, it is concluded that maize- oat- *tulsi* blend flour improved the nutritional value of extruded developed products.

Keywords: Maize, oat, *tulsi*, blend flour, extruded products, proximate composition

Introduction
Blend flour technology refers to the process of mixing various different cereals flours with or without addition of green leaves powder in proper proportions to make economic use of local cultivated crops to produce high quality food products. Some studies were reported on the use of coarse cereals – green leaves combination for the production of various products (Nagares *et al*., 2011) [4]. It can be deduced from these reports that the qualities of product depend on the proportional composition of the composites and flour properties (Oladunmoye *et al*., 2010) [5]. Despite a recent advance in formulation of non-wheat flour from cereal, legumes and green leaves combination, the replacement of gluten in cereal-based products, such as traditional and extruded products still represent a significant challenge of technology (Gallagher *et al*., 2004) [3]. Therefore the present study was conducted to prepare the *tulsi* based blend flour extuded products and their organoleptic and nutritionally analyzed.

Material and Methods
Procurement of material
The seeds of QPM mixture (quality protein maize) was procured from experimental farms at Regional Research Station, CCS HAU, Uchani, Karnal, oat (Avena sativa) from Forage section, tulsi (Ocimum sanctum L.) leaves procured from section Medicinal Aromatic and Underutilized Plants Section, Department of Genetics and Plant Breeding, College of Agriculture, Choudhary Charan Singh Haryana Agriculture University, Hisar.

Processing of grains
The *tulsi* leaves were trimmed in order to remove any dead or spoiled part. Than washed and freeze dried at -40 C0 temperature and stored in clean and hygienic condition for further use. The dried unprocessed samples of maize and oat were ground to fine powder in an electric grinder and then stored in plastic containers at room temperature for future use.

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Preparation of blend flours

Ground unprocessed maize, unprocessed oat flour and dried *tulsi* leaves powder were used to prepare blend flour. Six types of blend flours were prepared. Type I, II and III blend flours were prepared from maize: oat in ratio 85:15, 70:30 and 55:45 (W/W), Type IV, V and VI blend flours were prepared from maize: oat: *tulsi* leaves in ratio of 80:15:5, 65:30:5 and 50:45:5(W/W). The resultant blends were passed through 60 mesh size sieve to obtain uniform mixing.

Organoleptic evaluation of flour blends based extruded products

For selecting the acceptable products for further study, the above mentioned baked products were subjected to organoleptic evaluation by a panel of ten judges drawn from the I.C. College of Home Science, Chaudhary Charan Singh Haryana Agricultural University, Hisar, Haryana. The judges were asked to record the quality characteristics i.e. colour, appearance, aroma, texture and taste by employing a nine-point Hedonic Rating Scale as given in Annexure-I.

Determination of proximate composition

Moisture in the samples was calculated by employing the standard methods of analysis (AOAC, 2000). Crude Protein was estimated using micro-kjeldahl method with KELPLUS nitrogen estimation system. Crude fiber, ash and total carbohydrate was estimated by the standard method of analysis (AOAC, 2000). Crude fat was estimated by standard method (AOAC, 2000) using soxhlet extraction apparatus.

Statistical analysis

The obtained data were statistically analysed using ANOVA and t-test.

Results

The organoleptic characteristics of pasta, vermicelli and macaroni revealed that refined flour pasta, vermicelli and macaroni which were served as control was rated as 'liked very much' by the judges. Table 1 showed the mean scores of overall acceptability of Type-I, Type-II, Type-III blend flours based pasta were 7.82, 7.96 and 7.46, respectively. *Tulsi* leaves supplemented Type-IV and Type-V blend flours based pasta scored 7.22 and 7.66 for overall acceptability and were in the category of 'liked moderately' while, Type VI pasta scored 6.96. The mean scores for overall acceptability scores of Type-I, II and III blend flours based vermicelli and macaroni were rated as 'liked moderately' (Table 2 and 3). *Tulsi* leaves supplemented Type-IV, V, and VI blend flours based vermicelli and macaroni scored as 'liked moderately'.

Significant differences were also observed in proximate composition of three types of pasta, vermicelli and macroni. Crude protein content was higher in Type-II pasta (Table 4). *Tulsi* leaves supplemented Type V pasta had highest amount of crude fiber and ash. Total carbohydrate content was significantly higher in control pasta. Table 5 showed the *tulsi* leaves supplemented Type V vermicelli had highest amount of crude fibre and ash content as compared to Type-II and control vermicelli. Significantly highest amount of moisture, crude protein and crude fat content was observed in Type-II vermicelli. Control vermicelli had maximum amount of total carbohydrates. Proximate composition of three types of macaroni indicated that Type-V macaroni contained highest amount of crude fat and crude fibre while, moisture and crude protein were found in Type-II macroni. Whereas, total carbohydrate content was observed maximum in control macaroni (Table 6).

Table 1: Mean scores of organoleptic characteristics of maize-oat-*tulsi* flour blends based pasta

Level of supplementation	Colour	Appearance	Aroma	Texture	Taste	Over all acceptability
Control (RF::100%)	8.45±0.16	8.45±0.16	8.4±0.16	8.5±0.16	8.45±0.16	8.45±0.16
Maize : oat						
Type-I (85 : 15)	7.9±0.10	7.9±0.10	7.7±0.15	7.82±0.10	7.8±0.18	7.82±0.09
Type-II (70 : 30)	8 ±0.26	8.07±0.26	7.98±0.23	7.87±0.26	7.91±0.26	7.96±0.25
Type-III (55 : 45)	7.30±0.26	7.3±0.26	7.4±0.22	7.6±0.22	7.7±0.21	7.46±0.21
CD (*P*<0.05)	0.12	0.15	0.17	0.16	0.21	0.26
Maize: oat: *tulsi* leaves						
Type-IV (80:15:5)	7.5±0.4	7.2±0.29	6.9±0.23	7.2±0.29	7.3±0.33	7.22±0.29
Type-V (65:30:5)	7.4±0.16	7.6±0.16	7.7±0.15	7.9±0.10	7.7±0.15	7.66±0.07
Type-VI (50:45:5)	6.5±0.16	7.2±0.24	6.4±0.16	7±0.04	7.7±0.15	6.96±0.06
CD (*P*<0.05)	0.15	0.09	0.19	0.21	0.25	0.28
CD (*P*<0.05) for all treatments	0.66	0.63	0.54	0.53	0.61	0.52

Values are mean ± SE of ten independent determinations
RF = Refined flour

Table 2: Mean scores of organoleptic characteristics of maize-oat-*tulsi* flour blends based vermicelli

Level of supplementation	Colour	Appearance	Aroma	Texture	Taste	Over all acceptability
Control (RF::100%)	9±0.03	8.5±0.16	8±0.14	8.4±0.16	8.6±0.16	8.5±0.04
Maize : oat						
Type-I (85 : 15)	7.8±0.13	7.8±0.21	7.78±0.13	7.68±0.13	7.56±0.21	7.72±0.15
Type-II (70 : 30)	7.91±0.21	7.9±0.23	7.8±0.16	7.8±0.10	8±0.16	7.88±0.08
Type-III (55 : 45)	7.5±0.27	7.1±0.27	7±0.25	7.3±0.30	7.39±0.37	7.25±0.27
CD (*P*<0.05)	0.11	0.16	0.19	0.18	0.13	0.23
Maize:oat : *tulsi* leaves						
Type-IV (80:15:5)	7.17±0.41	7.06±0.30	7.32±0.24	7.47±0.24	7.6±0.23	7.32±0.26
Type-V (65:30:5)	7.21±0.23	7.18±0.23	7.5±0.26	7.66±0.26	7.73±0.26	7.45±0.23
Type-VI (50:45:5)	7.11±0.29	7±0.29	7.15±0.16	7.3±0.16	7.29±0.24	7.17±0.21
CD (*P*<0.05)	0.15	0.18	0.21	0.16	0.19	0.27
CD (*P*<0.05) for all treatments	0.72	0.70	0.58	0.57	0.69	0.56

Values are mean ± SE of ten independent determinations
RF = Refined flour

Table 3: Mean scores of organoleptic characteristics of maize-oat-*tulsi* flour blends based macaroni

Level of supplementation	Colour	Appearance	Aroma	Texture	Taste	Over all acceptability
Control (RF::100%)	9±0.05	9±0.07	8±0.04	8±0.06	8.5±0.16	8.5±0.33
Maize : oat						
Type-I (85 : 15)	7.9±0.18	7.5±0.22	7.7±0.21	7.87±0.10	7.82±0.06	7.75±0.10
Type-II (70 : 30)	8.0±0.20	8±0.14	7.9±0.13	7.89±0.13	7.92±0.13	7.94±0.10
Type-III (55 : 45)	7.2±0.32	7.1±0.32	7.68±0.20	7.8±0.20	7.73±0.21	7.50±0.21
CD (*P*<0.05)	0.11	0.15	0.17	0.19	0.22	0.24
Maize:oat : ***tulsi*** **leaves**						
Type-IV (80:15:5)	7.2±0.20	7.2±0.20	7.5±0.16	7.78±0.20	7.5±0.15	7.43±0.12
Type-V (65:30:5)	7.6±0.16	7.2±0.13	7.8±0.13	7.8±0.04	7.58±0.01	7.59±0.05
Type-VI (50:45:5)	7.5±0.16	7.03±0.16	7.1±0.16	7.4±0.16	7±0.24	7.20±0.09
CD (*P*<0.05)	0.09	0.15	0.18	0.14	0.20	0.29
CD (*P*<0.05) for all treatments	0.55	0.54	0.44	0.39	0.44	0.32

Values are mean ± SE of ten independent determinations
RF = Refined flour

Table 4: Proximate composition of pasta based on flour blends (%, dry weight basis)

Pasta	Moisture*	Crude protein	Crude fat	Crude fibre	Ash	Total carbohydrates
Control	59.79±1.10^a	8.69±0.06^c	4.26±0.34^a	1.17±0.01^c	8.93±0.06^c	76.93±0.36^a
Type-II	62.79±1.42^a	9.48±0.03^a	5.50±0.72^a	2.97±0.01^b	9.66±0.06^b	72.37±0.76^b
Type-V	61.72±1.53^a	8.96±0.03^b	5.76±0.53^a	3.64±0.02^a	10.73±0.06^a	70.89±0.53^b
CD (*P*<0.05)	4.72	0.01	1.92	0.05	0.23	2.01

Values are mean ± SE of three independent determinations
*Moisture on fresh weight basis
Control (RF 100%) Type-II (M:O 70:30) Type-V (M:O:T 65:30:5)
RF = Refined flour, M = Maize, O = Oat, T= *Tulsi* leaves

Table 5: Proximate composition of vermicelli based on flour blends (%, dry weight basis)

Vermicelli	Moisture*	Crude protein	Crude fat	Crude fibre	Ash	Total carbohydrates
Control	49.81±0.03^b	9.05±0.68^b	4.86±0.40^b	0.22±0.01^c	1.13±0.06^c	84.73±0.4^a
Type-II	51.81±0.10^a	10.41±0.03^a	6.40±0.41^a	1.52±0.01^b	1.40±0.04^b	80.26±0.39^b
Type-V	51.78±0.10^a	9.88±0.03^b	5.73±0.43^a	2.20±0.01^a	1.80±0.02^a	80.37±0.42^b
CD (*P*<0.05)	0.29	1.35	1.45	0.04	0.13	2.32

Values are mean ± SE of three independent determinations
*Moisture on fresh weight basis
Control (RF 100%) Type-II (M:O 70:30) Type-V (M:O:T 65:30:5)
RF = Refined flour, M = Maize, O = Oat, T= *Tulsi* leaves

Table 6: Proximate composition of macaroni based on flour blends (%, dry weight basis)

Macaroni	Moisture*	Crude protein	Crude fat	Crude fibre	Ash	Total carbohydrates
Control	60.91±0.03^a	8.79±0.06^c	3.90±0.41^b	1.11±0.06^c	8.02±0.01^c	78.20±0.40^a
Type-II	63.07±1.44^a	9.38±0.03^a	4.23±0.24^b	3.01±0.06^b	8.93±0.06^a	74.44±0.26^b
Type-V	62.89±0.03^a	8.96±0.03^b	5.56±0.28^a	3.65±0.03^a	8.13±0.06^b	73.67±0.25^b
CD (*P*<0.05)	2.87	0.01	1.11	0.06	0.18	1.08

Values are mean ± SE of three independent determinations
*Moisture on fresh weight basis
Control (RF 100%) Type-II (M:O 70:30) Type-V (M:O:T 65:30:5)
RF = Refined flour, M = Maize, O = Oat, T= *Tulsi* leaves

Conclusion

The present study was undertaken to evaluate the organoleptic evaluation, proximate of maize, oat and *tulsi* leaves blend flour products. Among extruded products, Type-II and Type-V blend flour products including pasta, vermicelli and macaroni were found in the category of 'liked moderately' by the panelists. Nutritional composition of pasta, macaroni and vermicelli revealed that significantly higher crude protein content was 9.48%, 9.38% and 10.41% observed in Type-II pasta macaroni and vermicelli while, crude fibre (3.64, 3.65 and 2.20%) content were significantly higher in Type-V pasta, vermicelli and macaroni. Total carbohydrate content was 76.93%, 78.20% and 84.73% significantly higher in control pasta, macaroni, and vermicelli.

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