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RESEARCH ARTICLE

ADDITION OF PEARL MILLET FLOUR TO WATERMELON SEEDS PORRIDGE TO IMPROVE A TRADITIONAL FOOD IN DARFUR

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ABSTRACT

A study was conducted on watermelon (*Citrullusvulgaris*) seeds porridge supplemented with the flour of pearl millet (*Pennisetumglaucum*) variety Dembi. The main objectives of the study were to determine the chemical composition and to improve the quality of processed porridge as well as to improve the nutritional value. The Data were collected on proximate composition, tannins, protein digestibility, minerals contents and sensory evaluation. The results of the chemical analysis showed that the watermelon seeds porridge contained 23.06% protein, and 5.95% fat, and the addition of pearl millet flour led to significant increase in fiber content from 3.65% to 3.93 % , ash content from 4.03% to 4.59% and carbohydrates from 16.85% to 20.09% and appreciable amount of minerals was detected (Ca 0.695, Na 11.0, P 10.67, Zn 0.979, Co 0.53, Mn 0.157,and Cu 0.858mg/kg) and there was insignificant increase in K and Mg from 52.74 and 27.1 mg/kg to 52.86 and 27.3mg/kg respectively; hence forming nearly a balanced diet. The percentage of *invitro* protein digestibility significantly increased from 85.09% to 87.75% with significant decrease of tannins content from 17.84% to 14.62%. The sensory evaluation test showed significant improvement of the quality attributes (taste, texture and general acceptability). It is concluded that there was improvement of processed porridge and the significant improvement of quality attributes showed that pearl millet flour is a good source of food nutrients as supplement to the watermelon seeds porridge. Therefore, it is recommended to supplement watermelon seeds flour with pearl millet flour.

INTRODUCTION

Good nutrition is a basic human right,in order to have a healthy population that can promote development, the relationship between food, nutrition and health should be reinforced in developing countries; one of the possible ways of achieving this is through the exploitation of available local resources, in order to satisfy the needs of the increasing population (Eka*et al.,* 2009). Nationally attention has been focused on under-utilized local seeds for possible development and use in the search for novel sources to complement the traditional ones, there are several of these under-exploited plant seeds in Africa. Watermelon (*citrullis vulgaris*) mainly propagated by seeds, belongs to the family cucurbitaceae and is believed to have originated from the dry areas of southern Africa (Simmonds, 1976).Watermelons are usually considered as juicy and sweet, red fleshed fruits to be enjoyed as a dessert or thirst quencher on hot days,infact, it is a lot more than that , seeds are for instance used to prepare porridge and considered as a source of protein and fat in the diet (van der Vossen*et al*. 2004).In West African countries, the habit of using watermelon seeds as a food source is reported; in the drier areas of Africa water melon fruit provide a source of liquid as a living canteen.Loukou*et al.,* (2007) In Africa and indeed Sudan while the pulp, roasted seeds are eaten and edible oil extracted, seed kernel flour is used to produce food (porridge) in Darfur in western Sudan, This indigenous food offers nutritional and functional benefits on the basis of its oil, protein, minerals, and fiber contents(Dawood,2012).Millet are indigenous Africa Cereals that, unlike wheat or rice, are well adapted to Africa semi- arid and subtropical agronomic conditions millet grow under difficult ecological conditions and tolerate poor soils and a certain degree of drought better than any other cereal crops (Obiland,2003). There are nine species of millet cultivated around the world and pearl millet is most widely grown species in Africa (FAO, 2004).Pearl millet is ranging second crop after sorghum in the Sudan. It's the preferred stable food crop for majority of the inhabitants of western Sudan (Abuelgasim and Hassan, 2006).Women in rural Sudan are key innovators; they are developing new ways to secure food supplies for their families, women developed a new food source from watermelon which widely grown in most rural areas of Sudan.

Women make porridge from dried watermelon seeds. The well exploitation of local available food raw material in rural areas to overcome the lack of cereals as stable food in the Sudan are depended on rainfall season, maximizing the use of watermelon seed products and minimizing its wastage, confirming its suitability and acceptability to human being, rising its economic value, all these points encouraged the researcher to carry out the present study.

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MATERIALS AND METHODS

Materials

Sudanese cultivar of watermelon seeds (*citrullusvalguris*) and pearl millet seeds Dembi (*pennisetumgluucum*) were brought from Nyala Agricultural Research Station, southern Darfur State .The seeds were cleaned and freed from foreign materials and broken seeds. Amount of 15kg of watermelon seeds were milled into flour to pass a 60 mesh sieves and amount of 10 kg of millet cultivar were milled to pass a 0.4mm screen. The flours were stored in polyethene bags at 4°C for processing and for more analysis, all chemicals used were of the analytical grade.

Methods

Flour preparation and Processing ofwatermelon seed (porridge): Flour was prepared for processing and samples were taken to execute proximate analysis .The supplemented flour was prepared by mixing 1kg from Dembi flour with 9kg from watermelon seeds flour to increase carbohydrate content in supplemented porridge. The processing was carried out in the Food Research Center (FRC), Khartoum, shambat.

Proximate analysis

Samples preparation: The samples were taken from watermelon seed flour, supplemented and none supplemented porridge to determine the chemical composition, protein digestibility and anti-nutritional factor. Determination of moisture content, crude fiber, fat, crude protein and ash content were carried out according to AOAC (1984).

Determination of carbohydrates

Carbohydrates were calculated by difference.

Carbohydrates without fiber = 100 – (Ash% +moisture + CP% + oil %)

Determination of total minerals

Minerals were extracted from the samples by dry ashing method according to AACC (2000) the amount of iron, Ca and Cu were determined using (AAS) atomic absorption spectrophotometer (AA6800). Ammonium vandate was used to determine phosphorous along with ammonium molybdate.Sodium and Potassium contents were determined by flame photometer (CORNIGEEL) according to AOAC (1984).

Potassium and sodium contents: Potassium and sodium contents of extracted sample were determined according to AOAC (1984) using flame photometer (corning 400).

Phosphorous content: The determination of phosphorous content was carried according to the method of AACC, (2000).

Determination of tannin content: Quantitative estimation of tannins was carried out using the modified vanillin – HCl method according toPrice et al. (1978). The reagent was prepared just at need to use by mixing equal volumes of 1% vanillin methanol and 8% HCl methanol. It was discarded if trace of color appeared.

Tannin standard curve: Catechin was used to prepare the standard curve. That was done by adding 600 mg of D (+) Catechin to 100 ml of 1% HCl methanol. From this stock solution various dilutions were prepared. Five ml of vanillin_HCL reagent (0.5% were added to 1 ml of each dilution. The absorbance was read using spectrophotometer (JENWAY 6305 UV/V) at 500 nm after 20 min. from addition of reagent at 30°C.The absorbance was plotted against catechin concentrate.

Determination of *invitro* protein digestibility: *Invitro*protein digestibility was carried out according to Saunders *et al.,* (1973) method; two hundred milligrams of the sample were placed into a 50ml centrifuge tube. 15 ml of 0.1 M HCl containing 1.5 mg pepsin were added and the tube was incubated at 37^0C for 3h the suspension was then neutralized with 0.5M NaOH (calculated 3.3 ml) then treated with 4 mg of pancreatic in 7.5ml of 0.2M phosphate buffer (pH 8.0) containing 0.005M sodium azide, the mixture was then gently shaken and incubated at 37^0C for 24h, After incubation the sample was treated with 10 ml trichloroacetic acid and centrifuged at 50.000rpm for 2min at room temperature, nitrogen in the supernatant was estimated using micro kjeldhl method.

Sensory evaluation of watermelon seed porridges: Sensory evaluation was conducted using a test panel of 25 persons, the panelists were asked to evaluate for color, taste, texture, mouth feel after taste and general acceptability so as to give grades: 1 as excellent, 2 very good, 3 good, 4 as bad (Gomez and Gomez 1984).the panel members consisted of staff and students randomly selected from the poly techniques community, Samples were presented in two digits coded white plastic dishes. The order of presentation of the samples to the judges was randomized, clean tap water was provided for the judges to rinse their mouth in between evaluations.

Statistical analysis procedure

Procedure: Data generated were subjected to Statistical Analysis System. Randomized Complete Design (RCD) was performed.means were then tested and separated using Dancan'sMultiple Range Test (DMRT) as reported by (Gomez and Gomez. 1984).The analysis of variance was performed to examine the significant effect in all parameters measured. The main effects which were taken into consideration in this study (data subjected to SAS) were all chemical composition elements, anti nutritional factor (tannin), protein digestibility and sensory evaluation data, all the samples were of trireplicated.

RESULTS AND DISCUSSION

Fat content: Table (1) shows the fat content of watermelon seed flour as 42.51% this value is less, comparable to the values for varieties of melon oil seeds ranging from 47.9 - 51. 1% reported by Ige*et al.;* (1984), for pumpkin seed 49.2% and 47. 01% by Aisegbu, (1987) and Fagbemi and Oshodi, (1991) and Watermelon seed flour (*Citrullus vulgaris*) 44.5-54.3% oil Sharma *et al*.; (1994). The possible reason for such a difference could be attributed to varietal and regional differences. Fat is important in diets because it promotes fat soluble vitamin absorption. It is a high energy nutrient and does not add to the bulk of the diet Bogert*et al*.; (1994).There was mass decrease in fat content of watermelon seed porridges as 7.06% for none supplemented and 5.96% for supplemented, this highly significant(P=0.01) decrease was due to removal of extra oil present on food surface and it might be advantageous in term of utilizing this as cooking oils in homes or traditional method for oil extraction while the remaining fat content in processed porridges represent good energy source and give food palatability.

Protein content: Table (1) shows the protein content of watermelon seed flour, supplemented and none supplemented (porridge) as 26.07%, 25.92% and 23.06 % respectively. These crude protein values are in/or close agreement to protein rich foods such as soybeans, cowpeas, Pigeon peas, melon, pumpkin and gourd seeds ranging between 23.1- 33.0% Olaofe*et al.*;(1994). The recommended daily allowance for protein for children ranges from 23.0-36.0g and for adults, 44-56g NRC, (1989).

porridge) as 3.65%, 3.63% and 3.91% respectively. These values are in/or close to the range 3.2-4.7% reported by Sharma *et al*., (1994) and 3.84% compared with some other seeds. Maintenance of internal distention for a normal peristaltic movement of the intestinal tract is the physiological role which crude fiber plays. It has been reported that a diet low in fiber is undesirable as it could cause constipation and that such diets have been associated with diseases of colon like piles, appendicitis and cancer Okon, (1983).

Carbohydrate content

Table (1) shows the carbohydrate content of watermelon seed (flour, supplemented porridge and none supplemented porridge) as 17.89%, 16.85% and 20.59% respectively. These values are low comparable to other starch based foods and shows that watermelon seeds may be more of a body building food and incapable of supplying the daily energy requirements of the body therefore supplementing with flour of higher

Table 1. Proximate composition of raw watermelon seeds flour and watermelon seeds porridge A (none supplemented)and B (supplemented)

Sample	Moisture content (%)	Fat content (%)	Crude protein (%)	Ash content (%)	Crude fiber (%)	Carbohydrates (%)
Raw watermelon seeds flour	5.25±0.10^{c}	42.51±0.60^{a}	26.07±0.06^{a}	4.56±1.34^{a}	3.65±0.06^{b}	17.89±0.14^{b}
None supplemented Porridge	42.71±0.25^{a}	7.06±0.07^{b}	25.92±0.03^{b}	4.51±0.03^{a}	3.63±0.04^{c}	16.85±0.08^{c}
Supplemented porridge	41.97±0.60^{b}	5.96±0.06^{c}	23.06±0.21^{c}	4.59±0.05^{a}	3.93±0.03^{a}	20.59±0.18^{a}
$Lsd_{0.05}$	0.3055**	0.7007**	0.2605*	1.542$^{n.s}$	0.0893*	0.2754*
SE±	0.0107	0.1025	0.0753	0.0457	0.0251	0.0703

MeanSD value(s) bearing same superscript(s) within a column (for each parameter) are not significantly different (P<0.05).

Table 2. Anti-nutritional factors and invitro protein digestibility of raw watermelon seeds flour and watermelon seeds supplemented and non-supplemented porridge

Sample	Tannins(mg/100g)	*In vitro* protein digestibility (%)
Raw watermelon seeds flour	17.84±0.36^{a}	85.09±0.03^{c}
None supplemented Porridge	16.81±0.17^{b}	87.05±0.05^{b}
supplemented porridge	14.62±0.04^{c}	87.75±0.07^{a}
$Lsd_{0.05}$	0.4056*	0.1094**
SE±	0.1031	0.03162

MeanSD value(s) bearing same superscript(s) within a column (for each parameter) are not significantly different (P<0.05).

Table 3. Minerals content of raw watermelon seeds flour and watermelon seeds porridge

Minerals (mg/kg)	Samples			$Lsd_{0.05}$	SE±
	Raw watermelon seeds flour	None supplemented Porridge	supplemented porridge		
Ca	0.668±0.00^{c}	0.672±0.00^{b}	0.695±0.00^{a}	0.000632*	0.000183
Mn	0.139±0.00^{c}	0.144±0.00^{b}	0.157±0.00^{a}	0.000632*	0.000183
Co	0.030±0.00^{c}	0.032±0.00^{b}	0.053±0.00^{a}	0.000632*	0.000183
Cu	0.843±0.00^{b}	0.850±0.00^{a}	0.858±0.00^{a}	0.2364*	0.06831
Fe	1.901±0.00^{c}	1.903±0.00^{b}	1.942±0.00^{a}	0.000632*	0.000183
Na	10.36±0.00^{c}	10.37±0.00^{b}	11.01±0.00^{a}	0.000632*	0.000183
K	52.74±0.00^{b}	52.80±0.00^{b}	53.00±0.00^{a}	1.998**	0.317
Mg	27.10±0.00^{c}	27.30±0.00^{b}	27.90±0.00^{a}	1.63**	0.421
P	9.81±0.00^{c}	9.83±0.00^{b}	10.67±0.00^{a}	0.000632*	0.000183
Zn	0.954±0.00^{c}	0.973±0.00^{b}	0.979±0.00^{a}	0.000632*	0.000183

MeanSD value(s) bearing same superscript(s) within a column (for each parameter) are not significantly different (P<0.05).

Ash content: Table (1) shows the ash content of watermelon seed (flour, supplemented porridge and none supplemented porridge) as 4.56%, 4.51% and 4.59% respectively. These values are within the range of 3.01-5.01%reported by Madaan and Lai,(1984) and in close agreement to 3.2-4.7% reported by Sharma *et al*.;(1994).These values shows a good source of mineral matters.

Fiber content: Table (1) shows the fiber content of watermelon seed (flour, supplemented porridge and none supplemented

carbohydrate content is necessary, the result showed significant increase from 16.85% in none supplemented porridge to 20.59% in supplemented porridge.

Tannins content

Table (2) shows tannins content of watermelon seed (flour, supplemented porridge and none supplemented porridge) as17.84%, 16.81% and 14.62^{c}%respectively. These values are low comparable to other oil seeds flour. The results of the food under study showed that tannin content decrease significantly ($P\leq 0.05$) due to the effect of cooking process (as heat degradation).

***Invitro* protein digestibility:** Table (2) shows *invitro* protein digestibility (*IVPD*) of watermelon seed (flour, supplementedporridge and none supplemented porridge) as 85.09%, 87.05% and 87.75%, respectively. These values revealed the highly significant ($P\leq 0.01$) increase of (*IVPD*) in the food under study, the possible reason for such difference could be attributed to decrease of anti nutritional factors during cooking process.

Table 4. Sensory evaluation of watermelon seeds porridges

Sample	Quality attributes				
	Color Hedonic scores	Taste	Texture	Mouth fell after taste	General acceptability
None supplemented porridge	2.00 ± 0.60^{a}	2.68 ± 0.07^{a}	1.88 ± 0.21^{a}	2.04 ± 0.05^{a}	1.88 ± 0.03^{b}
supplemented Porridge	2.04 ± 0.25^{a}	2.04 ± 0.06^{b}	1.04 ± 0.03^{b}	1.92 ± 0.03^{a}	2.20 ± 0.04^{a}
$Lsd_{0.05}$	$0.0632^{n.s}$	0.4976^{*}	0.6349^{*}	$0.9077^{n.s}$	0.6349^{*}
SE±	0.0048	0.0235	0.1835	0.1835	0.1835

MeanSD value(s) bearing same superscript(s) within a column (for each quality attribute) are not significantly different ($P<0.05$).

Mineral content: Table (3) shows the mineral contents of watermelon seed (flour, supplemented porridge and none supplemented porridge) . Obtained values are in/or close to the result reported by Hassan, (1999). there were highly significant ($P\leq 0.01$) increase of macro minerals (K and Mg) and significant ($P\leq 0.05$) increase of (Na and Ca) while there were significant ($P\leq 0.05$) increase of Mn,Co,Cu,Fe,Zn and P as micro minerals in general.Thus, it can be considered that a moderate amount of water melon seed minerals can play important role in maintaining a constant osmotic pressure and pH in cell fluids in addition to the balance of ions in the blood asshowed about watermelon seed composition, Wikipedia,(2011).

Sensory evaluation: Table (4) shows the sensory evaluation scores of watermelon seed (supplemented and none supplemented porridge) these values are significant at ($P\leq 0.05$) in quality attributes (taste, texture and general acceptability). The panel test result showed very good color, texture, mouth fell after taste and general acceptability and as excellent in taste of none supplemented porridge. While in supplemented porridge result as good in (texture, very good in color, taste and mouth fell after taste) and as excellent in general acceptability.

Conclusion

The interpretation of the results obtained in this study revealed the following points:

- Watermelon seeds can be of economic importance as flour with good water intake when processed.
- The low moisture content in watermelon seeds flour might be advantageous for flour shelf life
- Mass increase of water intake of watermelon seeds flour during cooking enhancedgelatinating process
- Mass decrease in fat content due to oil removal from processed food.
- Removed oils can be used as cooking oils of high nutritional and therapeutic value.
- There was significant ($P=0.05$) decrease in protein content of WMS supplemented porridge this might be attributed to low protein content in pearl millet(Dembi) flour
- The ash content was slightly increased in processed food; this might be due to close agreement or similar content of supplemented flour parts
- There was significant increase in fiber and carbohydrate content of supplemented porridge, this improves the food digestion in intestinal tract of human being, and regarded as good source of energy, this attributed to pearl, millet flour ,hence form semi balanced diet
- The mineral content was high in (K and Mg) and moderate in (Na,Ca,Mn,Co,Cu,Fe,Zn and P)
- There was low tannin content in watermelon seeds flour and it was decreased when processed through the effect of heat processing with significant increase of protein digestibility of supplemented porridge
- The sensory evaluation signed good results in general acceptability of supplemented porridge

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