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Effect of Two Sudanese Cooking Methods on the Nutritional Value of Potato (*Solanum tuberosum*) Variety Draga

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Abstract: This work was carried out to assess the nutritive value of draga variety of potato which was subjected to two cooking methods (boiling and frying). Proximate chemical analysis, minerals content, amino acids content and sensory evaluation were studied. Boiling resulted in insignificant decrease in protein, ash, fat and starch and increase in fibre and a significant decrease in total carbohydrates, while frying increased all tested components (protein, ash, fat, fibre, starch and total carbohydrates). Generally, boiling and frying decreased significantly Na, K, P and Mg contents, while Fe was significantly increased. Ca was significantly increased by frying, while it was significantly decreased by boiling. The amino acids results showed that the two methods of cooking destructed phenylalanine, methionine, tyrosine and lysine. However, arginine was destructed by boiling only. Tryptophan recorded complete absence in all samples (raw, fried and boiled). Other amino acids (leucine, isoleucine, valine, histidine, aspartic acid, serine, glutamine and glycine) decreased by boiling and frying. Sensory evaluation revealed that there was no significant difference between the two methods of cooking with regard to texture and colour. However, flavour, taste and overall quality of fried potatoes were more acceptable than boiled ones.

Key words: Potato; cooking style; nutritive value; draga variety

INTRODUCTION

The potato (*Solanum tuberosum* L.) is widely grown in the world and ranks fourth in food production, after wheat, maize and rice. It is the top of the root crops followed by cassava, sweet potato and yams. Potato does better than rice and wheat as an edible energy source (Hawkes 1990).

Potato provides a cheap source of energy in the human diet (Ali 2005) and a good source of vitamins and minerals. Cooking is an essential process to improve the digestibility of starchy vegetables including potato (Garcia and Goni 2000). The composition and nutrient contents of potato products vary depending on the method of cooking used. The most widely used methods of cooking are boiling, steaming, pressure cooking, baking and frying. Few years ago, microwave started to be used for the purpose of cooking. In Sudan, potato is usually cooked by boiling, frying and in the form of stew. It was apparently introduced by the British to the Sudan in the early twentieth century (Elneam 2004).

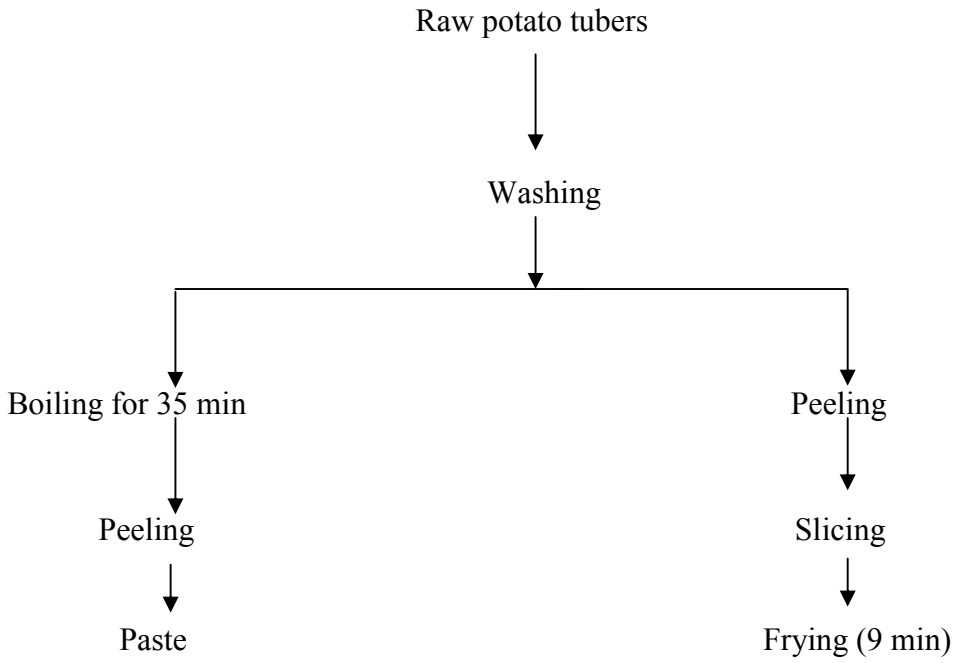
The aim of this study was to evaluate the effect of two Sudanese methods of cooking on the nutritional value of draga variety of potato and its acceptability to consumer.

MATERIALS AND METHODS

Materials: Potato draga variety and other preparation materials (sunflower oil, garlic and NaCl salt) were purchased from the local market, one day before preparation.

Frying process: An amount of 128 ml oil was heated to about 180°C, and 300 g of peeled potato slices were added (in batches) and left for about 9 minutes before they were removed from the oil. Then, traces of salt (NaCl) were added before testing.

Boiling process: Boiling was done in a sauce pan as follows: About 1.5 kg of unpeeled potato tubers were washed and put in the pan, and 1.024 litre of water was added. The process was done at 90°C for about 35 minutes. Then, the boiled tubers were mashed into a form of paste, and traces of oil, mashed garlic and salt (NaCl) were incorporated prior to testing.



Chemical analyses: The moisture, crude protein, fat, ash and fibre contents were determined according to AOAC (1984). The total carbohydrates were calculated by subtracting the sum of fat, protein, moisture and ash contents from 100 as described by West *et al.* (1988). Starch was assessed according to AOAC (1962). The minerals (Na, K, Mg, Ca and Fe) were determined by Perkin – Elmer 3110 atomic absorption spectrophotometer and phosphorus by vandatemoly bdate yellow method according to AOAC (1970).

Amino acids values were determined by Sykam – S 7 130 according to Moore and Stein (1963) procedure. For sample preparation, 200 mg were weighed in hydrolysis tube, then 5 ml of 6 N HCL were added and the tube was tightly closed and incubated at 110°C for 24 hours. The solution was filtered and 200 ml of the filtrate were evaporated at 140°C for an hour, and 1 ml diluting buffer was added to the dried sample. Then, 150µl of sample hydrolysate were injected in separation column at 130°C.

The profile of samples was performed with wave length fluorescence detector at excitation and emission wave length of 440 to 570 nm (HPLC, post column derivitization with ninhydrin and U V detection).

Organoleptic evaluation: The two potato products were assessed organoleptically by fifteen panelists who scored on five point hedonic scale (1 for excellent, 2 for very good, 3 for good, 4 for acceptable and 5 for unacceptable) (Watts *et al.* 1989).

Statistical analysis: The data were subjected to analysis of variance and means were separated using the Duncan, s multiple range test.

RESULTS AND DISSCUSSION

Proximate analysis: The fried potato showed a significant decrease (20.33%) in moisture content (Table 1), which may be due to water loss during the frying process. This finding agrees with that of Talburt and Smith (1959) who reported a decrease of 20%. On the other hand, boiled potato showed a significant increase of 3.84% in moisture content and this fairly agrees with the findings of Talburt and Smith (1959) (3.00%), while Kala and Prakash (2001) reported a decrease of only 0.5%.

Table 1. Chemical composition (%) of raw and cooked potato (draga variety)

Sample	Moi-sture	D.M.	Ash	Pro-tein	Fat	Fibre	COH	Starch
Raw	75.33^{b}	24.67^{b}	0.87^{c}	1.77^{c}	0.53^{b}	0.47^{b}	21.03^{b}	12.20^{b}
Fried	55.00^{c}	45.00^{a}	1.38^{b}	2.70^{b}	6.40^{d}	0.50^{b}	34.02^{a}	19.03^{a}
Boiled	79.17^{a}	20.83^{c}	0.50^{c}	1.37^{c}	0.47^{b}	0.57^{c}	17.92^{c}	10.90^{bc}

D.M.: Dry matter; COH: Total carbohydrates

Values with the same letter in the same column are not significantly different at $P \leq 0.05$, according to Duncan, s multiple range test.

The protein content decreased insignificantly by boiling from 1.77% to 1.37%. Kala and Prakash (2001) reported a decrease from 1.95% to 1.84%, while Pearson (1976) found a decrease from 2.13% to 1.56%. In contrast, frying caused a significant increase in protein from 1.77% to 2.70%. Talburt and Smith (1959) found a range of 1% - 2% of fried potato.

The fat contents of raw potatoes and boiled ones showed insignificant difference; however, frying ended up with a significant increase in fat content, and this seems logical since frying was done by oil. These findings are consistent with those reported by Talburt and Smith (1959), but Kala and Prakash (2001) found that fat content showed a slight increase after boiling.

The fibre content increased slightly by boiling, and this agrees with the findings of Varo *et al*. (1984) and Kala and Prakash (2001) who showed that boiling caused an insignificant increase in fibre content. Likewise, frying caused an insignificant increase in fibre content.

The boiled potato showed insignificant decrease in carbohydrates content, but frying caused a significant increase. Starch content decreased significantly by boiling, while frying caused a significant increase. The reduction of starch is attributed to the swelling of starch molecules by water.

As shown in Table 1, ash content insignificantly decreased by boiling (0.87% to 0.50%). A similar finding was reported by Kala and Prakash (2001) who found a non-significant decrease (0.78% to 0.73%). On the other hand, frying caused a significant increase in ash content (0.87% to 1.38%). Generally, these results do not agree with those obtained by Kala and Prakash (2001) who reported that cooking did not cause any significant difference in minerals content.

Minerals content: Ca, Na, K, P, Mg decreased by frying and boiling, while Fe increased significantly by both methods of cooking (Table 2). The increase of Fe may be attributed to the release of this metal during frying and boiling processing. These results are in agreement with those obtained by Kala and Prakash (2001).

Table 2. Minerals content (mg/100g) of raw and cooked potato (draga variety)

Mineral	Raw	Fried	Boiled
Calcium	16.87^{b}	23.3^{ab}	14.87^{b}
Sodium	24.67^{b}	4.50^{d}	9.50^{b}
Potassium	430.0^{a}	300.0^{b}	250.0^{c}
Phosphorus	52.00^{b}	45.0^{c}	47.0^{c}
Magnesium	31.77^{b}	22.67^{d}	25.67^{c}
Iron	1.76^{b}	1.97^{a}	1.93^{a}

Values with the same letter in the same row are not significantly different at $P \leq 0.05$, according to Duncan's multiple range test.

Amino acids content: Some of the amino acids (e.g. lysine, phenylalanine, methionine and tyrosine) were destructed by the two methods of cooking (Table 3). However, arginine was destructed by the boiling method only. Tryptophan was completely absent in all samples (raw, fried and boiled). Other amino acids (leucine, isoleucine, valine, histidine, aspartic acid, serine, glutamine and glycine) decreased by boiling and frying. The findings of Talburt and Smith (1959) regarding valine and isoleucine of fried potato compare favourably with those of the present study. Golaszewska and Zalewski (2001) found that the best quality of potato was achieved by dry cooking (frying).

Table 3. Amino acid content (mg/100g) of raw and cooked potato (draga variety)

Amino acid	Raw sample	Fried sample	Boiled sample
Lysine	55.9	nd	nd
Ieucine	119.86	3.07	2.06
Isoleucine	57.14	1.42	1.96
Threonine	nd	nd	nd
Phenylalanine	118.00	nd	nd
Tryptophan	nd	nd	nd
Valine	175.00	2.99	1.57
Arginine	99.50	2.54	nd
Histidine	39.30	2.5	1.98
Methionine	35.73	nd	nd
Aspartic acid	497.00	5.59	3.92
Serine	39.30	0.57	0.37
Glutamine	234.00	0.312	1.54
Glycine	94.37	3.22	0.15
Tyrosine	70.03	nd	nd
Alanine	nd	nd	nd

nd = not detected

Sensory evaluation: No significant difference was recorded in colour and texture between boiled and fried potatoes. In contrast, flavour, taste and overall quality showed significant difference between boiling and frying methods (Table 4) .Fried potato scored excellent in taste and very good in the other quality parameters, while boiled potato scored good in all quality parameters.

Table 4. Organoleptic quality of potato (draga variety) products

Sample	Colour	Flavour	Taste	Texture	Overall quality
Fried potato	1.47^{b}	1.86^{b}	1.2^{b}	2.47^{a}	1.73^{b}
Boiled potato	2.00^{ab}	3.0^{a}	3.2^{a}	2.60^{a}	3.2^{a}

Values with same letter in the same column are not significantly different at $P \leq 0.05$, according to Duncan's multiple range test.

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تأثير طريقتي طبخ سودانيتين على القيمة الغذائية لصنف البطاطس دراقا

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المستخلص: هدف هذا البحث إلى دراسة القيمة الغذائية لصنف البطاطس دراقا بعد تعريضه لطريقتين من الطبخ (الغلى والتحمير) ، ودرس التحليل التقريبى والمحتوى من المعادن والأحماض الأمينية ، وكذلك التقويم الحسى. أثبتت التحاليل أن الغلى أدى إلى تناقص غير معنوى فى البروتين والرماد والدهون والنشا ، وإلى زيادة فى الألياف ونقصاً معنوياً فى الكاربوهيدرات وأدى التحمير إلى زيادة فى كل المكونات (البروتين ، الرماد ، الدهون ، الألياف ، النشا ، الكاربوهيدرات) . عموماً فقد أدت عمليتا الغلى والطبخ إلى نقص معنوى فى الصوديوم والبوتاسيوم والفسفور والماقنيزيوم ، بينما زاد الحديد زيادة معنوية . وزاد الكالسيوم زيادة معنوية بالتحمير إلا أنه نقص نقصانا غير معنوى بالغلى . وأدت عمليتا الطبخ إلى إختفاء الأحماض الأمينية (لايسين ، فينايل ألنين ، مثيونين ، تايروسين) بينما إختفى الأرجنين بالغلى فقط . سجل التريبتوفان غيابا تاما فى كل العينات (الخام ، المحمرة ، المغلية) ، أما الأحماض الأمينية الأخرى (ليوسين ، آيسوليوسين ، فالين ، هستدين ، أسبارتك أسد ، سيرين ، قلوتمين ، القلايسين) فقد تناقصت بكل من الغلى والتحمير . وفيما يختص بالتقويم الحسى ، فقد أشارت النتائج إلى أن القوام واللون لم يسجلا فرقاً معنوياً بين طريقتى الطبخ ، وأن ألبطاطس المحمرة أكثر قبولاً من البطاطس المغلية من حيث الطعم والنكهة والجودة .