



## Nitrate and Nitrite Contents in French Fried and Chips Potato During Traditional Homemade Processing in Syria

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### ABSTRACT

The effects of potato French fried and chips during the traditional homemade processing on the changes in the content of nitrates and nitrites were determined. The experimental material was potato tubers of spunta variety collected from nine stages of a French fries and chips homemade processing. The results of the research carried out, revealed that the processes applied during French fries and chips making, had a significant influence on the decrease in the nitrate and nitrite contents in both intermediate and final products in comparison with the raw material. The losses of nitrate ion in potato chips and French fries were almost equally. While, the losses of nitrites were greater in potato chips than that for French fries. French fries ready for consumption contained only 23 % of the nitrate and 2.49 % of the nitrite found in the raw material, while the chips contained only 24 % of the nitrate and 0.59 % of the nitrite found in the raw material.

**Keywords:** Nitrate, Nitrite, potato, homemade, French fries, chips, Cadmium reduction column.

### INTRODUCTION

The potatoes (*Solanum tuberosum*) which go back to Andes (near Lake Titicaca) about 8,000 years ago is an annual herbaceous giving good yields under various soil and weather conditions and grow up to produces a tuber - also called potato - so rich in starch that it ranks as the world's fourth most important food crop, after maize, wheat and rice.<sup>1</sup> The consumption of potatoes varies from country to country, but takes remarkable position in a human diet (150–400 g per capita per day).<sup>2</sup>

In spite of the nutritional impotence of the potato, the potato itself naturally contains undesirable toxic compounds, two glycoalkaloids (solanine and chaconine) and two anions (nitrate and nitrite) which are normally found at low levels in the tuber comparing to the other part of the plant.<sup>3</sup>

The accumulation of nitrate and nitrite in potato tubers, depends on several factors such as: natural processes of potato grows, disorders in the metabolism, variety, soil, nitrogen fertilization, season and harvest time, ecological and conventional farms with consideration of the weather conditions (light intensity, temperature ... etc.), irrigation system, and finely storage condition.<sup>3-10</sup>

The distribution of nitrate in the tuber is not uniform, where the majority is found in and just under the skin, therefore preliminary processing of peeling can definitely reduce the level of these compounds.<sup>11,12</sup>

Nitrate per se is relatively non-toxic to humans and its toxicity attributed mainly to its reduction to nitrite.<sup>13</sup> Nitrate can be converted to nitrite through the mechanism of bacterial reduction as bio-transformation in the saliva and digestive system.<sup>14</sup> Moreover, the nitrite presented in stomach as a result of nitrate-nitrite

contained food intake may react with secondary and tertiary amines and amides to form N-nitroso compounds which have a carcinogenic potentiality.<sup>13-16</sup> Furthermore, excessive intake of nitrate and nitrite in the diet may cause toxic effects associated with the formation of methaemoglobinaemia (Blue Baby Syndrome) which produced by oxidation of haemoglobin by nitrite. Infants are more susceptible to this syndrome.<sup>13,14,17</sup>

Respecting to chronic effect of nitrate and nitrite, the IARC (2010), stated that, the JECFA (FAO/WHO expert committee on food additives) and SCF (The European Commission's Scientific Committee on Food) set an ADI (Acceptable Daily Intake) for nitrate ion as 0 - 3.7 mg/kg body weight per day (equivalent to 219 mg/day for a 60 kg person), and the ADI for nitrite as 0 - 0.06 mg/kg of body weight per day (equivalent to 3.6 mg/day for a 60 kg person).<sup>18</sup>

The national academy of sciences (NAS) stated that vegetables provide 87% of nitrate in a normal diet, while the other products including fresh and cured meat, and dairy provide the remainder.<sup>19</sup> The major sources of nitrate resulted from vegetables intake are potatoes and lettuce, the first because they are vegetables consumed in the largest quantity and the latter due to its high nitrate content.<sup>15</sup> Potato tubers contain nitrate in the level of < 200 mg/kg<sup>-1</sup> fresh weight and up to 60 mg/kg<sup>-1</sup> fresh weight for nitrite.<sup>15,20</sup>

The global consumed potato served by versatile of preparation ways (baked, boiled or fried) with may receipt forms.

The aim of the present study was to determine the effects of several stages of the traditional Syrian homemade French fries and chips potato (spunta variety) on the contents of nitrate and nitrates.



## MATERIALS AND METHODS

### Raw material Collection

10 Sample sets of fresh tubers of potato, spunta variety (the most variety available at that time) without any green spots or sprouting were taken from wholesale market in Damascus Syria. Collection of samples covered the period from the first of January till the end of April 2012.

### Preparing the traditional homemade French fries and chips

The previously 10 sample sets fresh tubers mentioned above, were prepared according to the commonly used Syrian homemade crispy French fries, and chips recipe which is somewhat different from the huge industrial production lines with the tools and techniques more specialized.

#### For French fries

The procedure includes the following steps:

(1) Scrubbing the potatoes clean, (2) Peeling the potatoes thoroughly (by using a vegetable peeler), (3) Rinsing the peeled potatoes, (4) Cutting the potatoes (by using a mandolin) into strips of about 8 by 8 mm. thickness and width, (5) Soaking the potato strips in cold water for 1 hour at room temperature, (6) Rinsing well in a colander and draining well, (7) Drying the potato strip thoroughly by using layers of absorbent paper towel (nitrite – nitrate free), (8) In pan fryer – deep fryer – heating the vegetable oil to about 375°C then Placing the potato strips in a single layer in deep fry basket; frying until the color turns light brown (about 10 minutes), (9) Removing the potatoes from the deep fryer allowing cooling for about 5 minutes, (10) Putting the fried potatoes back in the fryer and frying until the color turns golden brown (for another 5 minutes), (11) Draining in the metal basket on the absorbent paper towels.

#### For chips fries

All steps are the same as mentioned above, except for cutting of the potatoes (by using a mandolin) into slices of about 2 mm. thick and frying the potato slices in one step until the color turns golden brown on both sides (about 5 minutes).

Samples for the analysis were taken three times from each of the following stages:

1, potato unpeeled; 2, potato after peeling; 3, strips of French fries after soaking; 4 strips of French fries after drying; 5, French fries after stage I of frying; 6, French fries after stage II of frying; 7, chips slices after soaking; 8, chips slices after drying; 9, chips slices after frying.

### Analytical methods

The dry matter content were determined for the nine steps of homemade fries potato by taking 20 g sample (weighed to the nearest 1 mg) and drying in the oven at 105°C until constant weight were obtained.<sup>21</sup>

The nitrate and nitrite content were determined for the samples according to the ISO 6635.<sup>22</sup> The method involves extraction of the test portion with hot water (approximately 10 g of the test sample weighed to the nearest 1 mg), precipitation of the proteins, and filtration. Addition of sulfanilamide chloride and N-(1-naphthyl) ethylenediamine dihydrochloride to the portion of the filtrate, and spectrometric measurement of the red complex obtained in the presence of nitrite at a wavelength of 538 nm compared with standard nitrite solutions by using Spectronic Genesys 2 spectrophotometer. For nitrate determination, a reduction to nitrite was done in a portion of the filtrate by means of metallic cadmium. Nitrate content was calculated taking into consideration the difference between these two analytical results. All reagents were of analytical grade quality. Deionized water was used throughout the procedure. The method was continuously tested by standard addition of nitrate and nitrite. Recoveries have been found to be between 98 and 102%. The limit of detection was 0.34 ppm for nitrate and 0.05 ppm for nitrite. Analyses were run in duplicate.

The results were statistically analyzed employing ANOVA two way analysis of mean differences used together with Duncan's test (PASW statistics 18). The statistical analysis was performed at the significance level of  $p=0.05$ .

## RESULTS AND DISCUSSTION

In spite of that the Spunta potato variety is not the optimal choice for making fried potato, but it remains the most likely option for making homemade fried potato in Syria, being the most abundant variety in the wholesale market.

For comparison in the content of nitrate and nitrite during homemade potato fries processes, it was better to ascribe the results to dry matter.

In this study, the dry matter was determined for 10 sample sets of spunta potato variety through nine stages of making homemade crispy French fries and chips. In addition to the determination of nitrate and nitrite for this nine stages.

### The dry matter content

Table (1) shows the dry matter content during the homemade processes of French fried potato.

**Table 1:** Dry matter content (%) in 10 potato samples during homemade French fries processing

Stage	Mean $\pm$ SD	Minimum	Maximum
unpeeled potato	16.54 <sup>c</sup> $\pm$ 1.44	14.90	19.74
after peeling	16.45 <sup>c</sup> $\pm$ 1.59	14.38	20.16
after soaking	16.16 <sup>c</sup> $\pm$ 1.60	13.8	18.3
after drying	17.09 <sup>c</sup> $\pm$ 1.64	13.98	18.97
after stage I of frying	33.34 <sup>b</sup> $\pm$ 3.53	29.00	39.84
after stage II of frying	58.41 <sup>a</sup> $\pm$ 11.96	48.14	79.85

Differences between the values denoted with the same letter (a, b, c.) in a column are statistically insignificant at  $p=0.05$ ; SD: Standard Deviation.



During the initial stages of processing, the dry matter (DM) content did not change significantly; unpeeled, after peeling, after soaking, and after drying contained from 16.54 to 17.09 g /100 g. The final processes of French fries making, was resulted in partial dehydration of potato strips. The intermediate product after drying, contained 33.34 g/100 g, while the finished product (French fries ready for consumption) contained 58.41 g/100 g. The wide range differences of dry matter, at the last stage from 48.14 to 79.85 g/100 g may be attributed to the manual processing, and the a little bit difference in the thickness of the potato strips.

Table (2) shows the dry matter content during the homemade processes of chips potato.

**Table 2:** Dry matter content (%) in 10 potato samples during homemade chips processing

Stage	Mean ± SD	Minimum	Maximum
unpeeled potato	16.54 <sup>b</sup> ± 1.44	14.90	19.74
after peeling	16.45 <sup>b</sup> ± 1.59	14.38	20.16
after soaking	15.84 <sup>b</sup> ± 1.78	12.71	18.21
after drying	15.70 <sup>b</sup> ± 1.70	12.83	17.82
after frying	94.43 <sup>a</sup> ± 1.18	93.02	96.16

Differences between the values denoted with the same letter (a, b) in a column are statistically insignificant at p=0.05; SD: Standard Deviation.

As for homemade processes of French fries potato, in the initial stages of chips potato processing, the dry matter (DM) content, did not change significantly; unpeeled, after peeling, after soaking, and after drying contained from 16.54 to 15.70 g /100 g. The finished product of chips slices (chips ready for consumption) contained 94.43 g/100 g.

### The Nitrate and Nitrite content

Results for nitrates content are summarized in table 3 and table 4 respectively.

**Table 3:** Nitrate content (mg NO<sub>3</sub> kg<sup>-1</sup> DM) in 10 potato samples during homemade french fries processing.

Stage	Mean ± SD	Minimum	Maximum
unpeeled potato	925 <sup>d</sup> ± 449.68	362	1500
after peeling	718 <sup>c</sup> ± 327.82	307	1091
after soaking	467 <sup>b</sup> ± 173.69	260	695
after drying	448 <sup>b</sup> ± 163.11	227	667
after stage I of frying	428 <sup>b</sup> ± 136.82	252	627
after stage II of frying	211 <sup>a</sup> ± 84.15	92	290

Differences between the values denoted with the same letter (a, b, c, d) in a column are statistically insignificant at p=0.05; SD: Standard Deviation.

Regarding the results for the French fries, it can be noticed that the processes of making the French fries markedly decreased the nitrate content in both intermediate and finished form. About 23 % of nitrate content was removed during peeling, where the peeled

potatoes contained 718 mg NO<sub>3</sub> kg<sup>-1</sup> DM as an average value. As nitrate is water soluble, the stage of soaking reduced the nitrate content significantly (by 26 % on average) as compared with peeled potatoes. Significant decrease in nitrate content were not observed after drying, and after stage one of frying. A further considerable reduction in nitrate content was observed in frying stage two. Finally, French fries exhibited nitrate content of 211 mg NO<sub>3</sub> kg<sup>-1</sup> DM as an average of the sample group studied, which accounted about 23 % of the original nitrate content in the raw material.

**Table 4:** Nitrate content (mg NO<sub>3</sub> kg<sup>-1</sup> DM) in 10 potato samples during homemade chips processing.

Stage	Mean ± SD	Minimum	Maximum
unpeeled potato	925 <sup>e</sup> ± 449.68	362	1500
after peeling	718 <sup>d</sup> ± 327.82	307	1091
after soaking	453 <sup>c</sup> ± 150.71	308	679
after drying	390 <sup>b</sup> ± 125.88	252	592
after frying	224 <sup>a</sup> ± 67.80	127	307

Differences between the values denoted with the same letter (a, b, c, d, e) in a column are statistically insignificant at p=0.05; SD: Standard Deviation.

For chips fried potato, as for French fries, the processes of making chips markedly decreased the nitrate content in both intermediate and finished form.

The stages of soaking and drying, reduced the nitrate content significantly, more than that observed in French fries (by 36 % on average) as compared with peeled potatoes, this may be due to solubility of nitrate and the thin slices.

The nitrate content in chips, reduced to the average of 24 % of the original nitrate content in the raw material.

### The Nitrite content

Results for nitrites content are summarized in table 5 and table 6 respectively.

**Table 5:** Nitrite content (mg NO<sub>2</sub> kg<sup>-1</sup> DM) in 10 potato samples during homemade French fries and chips processing.

Stage	Mean ± SD	Minimum	Maximum
unpeeled potato	6.83 <sup>f</sup> ± 3.76	2.95	13.16
after peeling	4.87 <sup>e</sup> ± 3.25	2.03	10.31
after soaking	3.85 <sup>d</sup> ± 1.77	1.74	6.56
after drying	3.09 <sup>c</sup> ± 1.64	1.43	6.45
after stage I of frying	1.38 <sup>b</sup> ± 1.29	ND	3.69
after stage II of frying	0.17 <sup>a</sup> ± 0.15	0.08	0.50

Differences between the values denoted with the same letter (a, b, c, d, e, f) in a column are statistically insignificant at p=0.05 ; SD: Standard Deviation; ND: Not Detected.

**Table 6:** Nitrite content (mg NO<sub>2</sub> kg<sup>-1</sup> DM) in 10 potato samples during homemade chips processing.

Stage	Mean ± SD	Minimum	Maximum
unpeeled potato	6.83 <sup>d</sup> ± 3.76	2.95	13.16
after peeling	4.87 <sup>c</sup> ± 3.25	2.03	10.31
after soaking	3.69 <sup>b</sup> ± 1.37	1.65	5.81
after drying	3.80 <sup>b</sup> ± 1.29	1.71	5.33
after frying	0.04 <sup>a</sup> ± 0.03	ND	0.06

Differences between the values denoted with the same letter (a, b, c, d) in a column are statistically insignificant at p=0.05; SD: Standard Deviation; ND: Not Detected.

Regarding the results for the nitrite content during the homemade processes of French fries, as for nitrate, the processes of making French fries markedly decreased the nitrite content in both intermediate and finished form, the loss in the percentage of nitrite, was larger than of nitrates (About 29 % of nitrite content was removed during peeling process).

Nitrite as nitrate is water soluble, the stage of soaking, reduced the nitrate content significantly (by 44 % on average) as compared with unpeeled potatoes.

Drying stage reduced the nitrite content by 11% of the precede stage (the stage of soaking), further considerable reduction in nitrite content was observed in the frying stage, so the French fries as a finished prepared product contain only 2.49 % of the original nitrite.

As for chips fried potato, by comparing the decreases of nitrite content with that of nitrate content during the processes of chips making, the decrease in nitrite content was more drastic in the stages of soaking, drying and frying, and finished prepared chips contained only 0.59 % of the original nitrite.

The contents of nitrate and nitrite, during the frying processes of different varieties of potatoes have been investigated in several studies, emphasizing that there are obvious decreases in the levels of nitrate and nitrite found in the final products. For instance, the study of Mozolewski and Smoczynski (2004), on the effect of culinary processes on the content of nitrates and nitrites in potatoes, demonstrates that the effect of frying on the decrease in nitrate and nitrite levels for three potato varieties (Ibis, Mila and Muza), by calculating the decreasing percentage of the original levels of nitrate in the three varieties, it will be 50.03, 45.98, and 37.99 % respectively and for nitrite 23.80, 13.40, 17.69 % respectively.<sup>23</sup> The study of Rytel et al., (2005), on the changes in nitrate contents in potatoes during French fries processing for two varieties (Santana and Innowator) shows decreasing percentage of the original levels for nitrate 5.16 and 6.20 % of the two varieties respectively.<sup>11</sup> Also, the study of Peksa et al., (2006), on the changes of nitrate contents in potatoes during chip processing, for two varieties (Karlana and Saturna) shows decreasing percentage of the original levels for nitrate 8.10 and 9.83 % of the two varieties respectively.<sup>24</sup>

## CONCLUSION

It has been known, that the processes of making potato as a consumed food can have an effect on the remaining amount of nitrate and nitrite in a finished prepared form. This study showed that there is a clear decrease in the levels of nitrate and nitrite for spunta potato variety, through the stages of French fried and chip potato traditional homemade processing in Syria.

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