

Macronutrient Composition and Glycemic Index of Varied Prepared Meals of Irish Potatoes in Non Diabetic Subjects

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Abstract The glycemic response of white potatoes consumed in Nigeria was determined using various methods of cooking. Twenty healthy volunteers aged 20 to 30 years participated in the study. Subjects consumed 50 g baked potato (Bp), boiled potato consumed hot (Boph), boiled potato consumed cold (Bopc), French fries potato (Ffp) and white bread (control). Blood glucose concentration was determined before and after the test meals. The post-prandial blood glucose concentration over a period of 2 hours were determined half hourly, after the consumption of the test meals and blood glucose curves were constructed to calculate the glycemic index of the test meals. The results revealed that the glycemic values of potatoes varied significantly ($p < 0.05$) depending on cooking method, ranging from intermediate (boiled potatoes consumed cold) 55, to moderately high baked potatoes 74, boiled potatoes consumed hot 87. The French fries had glycemic value of 63 which are widely consumed all over the world including Nigeria. The glycemic index of potatoes is influenced by method of cooking and the white potatoes consumed in Nigeria have a moderately high glycemic index. Individuals who wish to minimize dietary glycemic index should be cautious of the prepared pattern of Irish potatoes.

Keywords: *Glycemic index, post-prandial, blood glucose, Irish potatoes*

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1. Introduction

Roots and tubers are the third largest carbohydrate food source in the world, with potatoes representing nearly half of all root crops consumed [1]. In 2000, the average American consumed about 140 lbs of potatoes per year and the amount that has more than double since 1970. Nearly half (48%) of Americans consumed potatoes at least three to four times a week as part of their dinner meal, and they consumed more baked, fried mashed or roasted potatoes than any other vegetables [2]. The health promoting effects of vegetables are well known [3,4] and thus, it is generally recommended that Americans eat more vegetables. Despite this, popular magazine [5], and book [6] and even scientific article [7,8] have all reported negative health effects of potatoes because of their purported high glycemic index.

Potato (*Solanum tuberosum* L) belongs to crops raised through tubers. Irish potato was first introduced in Nigeria in the late 19th century, through missionary activities [9]. Although production of potato has increased by over 120% in the last 10 years in Nigeria [10], it is still grossly below demand. To underscore the importance of potato in addressing the world food crisis, the United Nations officially declared 2008 as the international year of potato;

in order to raise its profile in developing nations, calling the crop "hidden treasure" [11] and [12]. Although potato has been identified to be the fourth most important root crop in Nigeria, after cassava, yam and cocoyam [13] with an efficient tuber crop in the country in terms of tuber yield and days of maturity. Research towards negative health effects of potato in Nigeria has not received much priority. The glycemic index (GI) values of potatoes reported in literature range from very low [14], for an unspecified type to very high for baked russets [15]. In addition, the structure can be affected by cooking and processing methods [16].

This research thus conducted was to determine the effect of cooking methods on glycemic response and to measure the glycemic index of white potato consumed in Nigeria.

2. Materials and Methods

2.1. Collection of White Potatoes (Irish)

The harvested potato tubers were ordered from the field, carefully selected with care to avoid skin bruises which create storage problems. They were separated into four groups and processed for the experimental diets.

2.2. Preparation of Test Meals

2.2.1. Baked Potato (Bp)

The Irish potatoes consumed in Nigeria were baked in oven preheated to 325 °F for 20 to 30 minutes, until their internal temperature was 200 °F. It was turned and cooked for additional 9 minutes, and wrapped in aluminum foil for consumption.

2.2.2. Boiled Potatoes Hot (Bph)

The Irish potatoes were cut into 25 to 3cm cubes boiled in salted water for 12 minutes until tender and drained and consumed immediately.

2.2.3. Boiled Potatoes Cold (Bpc)

The cooked Irish potatoes as described above were then kept in refrigerator for 12 to 24 hours and consumed cold.

2.2.4. French Fries (Ffp)

The Irish potatoes were cut into cubes placed in a baking dish covered with soya bean oil. This was cooked in preheated oven at 320 °F for 30 minutes turning the potatoes after 20 minutes, removed drained out excess oil and consumed.

2.3. White Bread

White bread served as the control meal, was purchased fresh and consumed. Macronutrient composition of test meals was analyzed for fat, protein, total carbohydrate and fiber. The test meals consisted of a portion of potato or white bread containing 50g available carbohydrate.

2.4. Experimental Design

Non-diabetic volunteers (n=20); 12 males and 8 females aged 20 to 30 years came to the laboratory in the morning after 10 - 12 hours overnight fast and consumed one of the test meals described plus a drink of one or two cups of water, tea or coffee with 30ml of 2% butterfat milk if desired (type and volume of drink chosen by each subject remained the same for the entire series of test foods). Each group of 4 subjects was given a single meal

of one of the four test foods on different days. Another one group of four consumed white bread instead of glucose as control. The serving size was determined by calculating the quantity of the test food that will give 50 gm carbohydrate when consumed. Blood samples (one to two drops) were obtained by finger prick before feeding at (0, 30, 60, 120 and 180 mins after the meal was given. While blood glucose was measured using an automated glucometer analyzer the (ACCU-CHECK Advantage II, Roche Diagnostics (GmbH, Germany) and ACCU-CHECK Advantage II test strips.

2.5. Glycemic Index Determination

Glycemic index values are classified as high (70 to 100) intermediacy (55 to 69) or low (< 55), [17]. But white bread and glucose have been used as reference food for glycemic index calculations. White bread was used in the study because subjects preferred it in place of glucose. It has been recommended that glucose index values should be expressed on the glucose scale [18]. If white bread is used as the reference food, conversion to glucose based glycemic index values (that is, glycemic index of glucose = 100) is achieved by dividing the bread-based glycemic index values by 1.4 because white bread elicit a glycemic response 29% less than that of oral glucose [18]. All glycermic values in this study have been converted to the glucose level scale.

2.6. Statistical Analysis

Statistical analysis was done by SPSS 15 statistical programme and comparisons between test foods; Baked potato (BP), Boiled potato consumed hot (Boph), Boiled potato consumed cold (Bopc), French fries potato (Ffp) and white bread (control) were done by the student's t-test. ANOVA and Duncan multiple range test were used to measure significant difference among the glucose index. The values with $p < 0.05$ were considered statistically significant.

3. Results

Table 1. Macronutrient composition of potato processed meals and white bread

Test meals (n=4)	Weight (g)	% Lipid (g)	% Protein (g)	% Carbohydrate (g)	% Fiber (g)	% Carbohydrate (g) White bread
Boph	376	0.4	6.30	59.1	9.0	50.0
Bopc	301	0.3	6.20	54.0	8.0	50.0
Bp	296	0.2	6.40	53.8	3.9	50.0
Ffp	233	9.1	5.51	55.5	5.5	50.0
Wb	104	1.7	7.50	52.8	2.8	50.0

Boph - Boiled potato consumed hot; Bopc - Boiled potato consumed cold; Bp - Baked potato; Ffp - French fries potato; Wb - White bread.

The GI of the four potato processed meals and white bread consumed are shown in Table 2. The GI ranged from intermediate values of 55 for Bopc to high value of 87 for Boph and white bread consumed was in this category with a value of 71. The Glycemic index values of the potato meals differed depending on cooking method. Bp and Ffp had moderated intermediate high values of 73 and 63 respectively. The Bopc and Ffp values were significantly less than that of Boph consumed.

Table 2. Glycemic indices of potato processed meals and white bread

Test (n=4)	Glycemic Index (GI)
Boiled potato consumed hot	87.4±7.20 ^b
Boiled potato consumed cold	55.2±5.30 ^a
Baked potato	73.5±8.70 ^b
French fires Foods potato	63.4±550 ^a
White bread	71.10±00

GI = glycemic index. Glycemic index classification: low <55; intermediate 56 to 69; high 70 to 100. Means in the same column not showing the same latter superscript differ significantly ($p < 0.05$).

4. Discussion

The glycemic index values of potato processed meals commonly consumed in Nigeria varied across a considerable range from 55 intermediate to a high 87 due to the processing methods of cooking the meals most notably baked potato meal had moderately high glycemic value of 74 almost similar to that of white bread glycemic index of 71. The global consumption of potatoes food is shifting from fresh potatoes to added value processed food products, and one of the main items in that category is the French fries served in restaurants and fast food centers. The world's appetite for factory made French fries is put at more than a million tons a year [11]. This shows that the packed potato French fries are widely consumed all over the world including Nigeria.

This study confirms the similar work conducted by [18] that had similar results that cooking methods affects glycemic index of meal as shown in Table 2 of this study. Research indicates that the method used to process, cook and store potatoes change the structure of the starch [16] as also seen in the Table 1 of this study. During cooking, starch granules take up water and swell (that is, gelatinization), which irreversibly disrupts the crystalline structure of the starch, making it able to be readily hydrolyzed by amylase. When starch is cooked, it forms an irregular structure that is resistant to digestion. Thus repeated cycles of cooling and reheating starch, progressively makes it resistant to digestion [19] causing delay digestion and absorption, thus reducing the glycemic response.

[15] found that the average glycemic index of potato is 92, while [20] reported a mean glycemic index of only 61. The difference as partly explained by [20] were precooked, frozen, and individual portions before consumption whereas, in studies by [15] potato were consumed immediately after cooking. The glycemic index values obtained in this study for baked and boiled were 75 and 87 somewhat higher than previously reported for baked and boiled white potatoes, (which ranged 59 to 64) [20]. These differences may be due to the fact in the previous study; the potatoes were precooked and reheated, whereas in the present study, they were consumed hot and cold immediately after being cooked.

The glycemic index value reported in the current study for French fries is 63. the relative low glycemic index value of the French fries might be due to the 9.1g fat they contain, because fat delays gastric emptying and the addition of as little as 5g of fat to 50g carbohydrate from white bread significantly reduces the peak rise of blood glucose [14]. There is evidence that the starch in French fries is more slowly digested than in baked potatoes [21] and this is also confirmed in this study. Indeed, the glycemic index of French fries was 17% less than that of baked potato.

One of the most popular ways of consuming potatoes is as potatoes salad in which the Irish potatoes are boiled cubed mixed with sliced garbage of lettuce and served cold; consuming cold versus hot potatoes had substantial effect on postprandial glucose. However, the reduction in blood glucose is much larger than can be accounted for by the reduction in the amount of digestible starch. Cooked potato starch contains about 7% resistant starch which increases to about 13% upon cooling [16]. The 6.5%

reduction in digestible starch accounts for 20.0% of reduction in blood glucose observed. Thus, the majority of the effect is likely due to a reduction in the rate rather than the amount absorbed.

5. Conclusion

This study demonstrated that glycemic values of potatoes vary depending on their method of preparation. The Irish potatoes consumed in Nigeria have a moderately high glycemic index. Individuals who wish to minimize dietary index are advised to precook potatoes and consume them cold or reheat.

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