The effect of mixing rice with mung bean in different food meals on postprandial blood glucose level in healthy adults

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Abstract. Rice is known as carbohydrate rich food and may tend to increase blood glucose levels rapidly. This work was designed to mix rice grains with mung beans to control releasing blood glucose and to keep a normal blood sugar level. Five food meals of rice and mung bean were prepared. The first meal was just 100% cocked rice, the second was 75% rice and 25% mung bean, the third was 50% rice and 50% mung bean, the fourth was 25% rice and 75% mung bean and the fifth was 100% mung bean. 25 volunteers aged between 18 – 22 years were subjected to the test and systematically given these food meals where they all had these food meals at intervals. The blood glucose of each volunteer was measured at 30, 60, 90, 120, 150, and 180 minutes using the glucocard-01 device. It was found that mean blood glucose levels were varied between measuring times and examined treatments. However, minimum blood glucose was 80.0±2.2 mg/dL in individuals who had an only mung bean meal only after 180 minutes to a maximum of 146±4.4 mg/dL in those who had a rice meal only but after 90 minutes. From the obtained results, it seems clear that blood glucose levels were correlated negatively with increasing mung bean quantity to rice meals where higher levels were recorded in those volunteers who had a rice meal only and started to decrease with increasing mung bean percentages. Key words: Rice, Mung bean, Blood Glucose, G. index, Body mass index.

1. Introduction.
Most human communities worldwide suffer from metabolic problems caused by food styles resulted in fatal disease commonly known as diabetes Mellitus ending in several health disorders such as dysfunction, long term deterioration and failure of various organs. This disease is characterized by elevated blood sugar (hyperglycemia) caused by abnormal metabolism of mainly carbohydrate food due to insulin secretion deficiency and insulin function defect [1][2][3]. Rice (Oryza sativa L.) is a miracle food for more than half of the world's population and more than for most Iraqi people. Polished rice grain consists of main carbohydrates (mostly starch) and some protein and fat [4][5]. However, white rice contains several mineral ions [6] such as magnesium, phosphorus, manganese, selenium, iron [6], thiamine [7] and riboflavin (vitamin B2) and niacin (vitamin B3) [8]. However, parboiling affects rice thiamine, protein and fat [9] while the polishing process affects both glycemic index and antioxidants [10]. On the other hand, mung beans are crops with various contents of protein, fat, fibre, and carbohydrates [11] as well as in addition to amino acids and antioxidants [12]. The glycemic index is a criterion that measures blood sugar level where it is a value assigned to foods based on how slowly or how quickly those foods increase blood glucose levels [13,14]. Foods low on the glycemic index (GI) scale tend to release glucose slowly and steadily. Foods that are high on the glycemic index release glucose rapidly [15]. Also, Low GI foods tend to foster weight loss, while foods high on the GI scale help with energy recovery after exercise, or to offset hypo- (or insufficient) glycemia.

It was well reported that white rice has a glycemic index of 70 or higher [16] where it contains amylase and amylopectin starches where the rice amylase is lighter and fine when the amylose is higher but it is much creamier and sticker when the amylopectin is high [17][18]. Other studies have found a significant negative relationship between rice amyllose content and
glycemic index [19][20][21] and a positive relationship between food carbohydrates of rice and wheat and glycemic index [22][23]. Apparently, white rice is classified as medium to high glycemic index [24][25] depending on many factors such as type of starch [26], fibre viscosity [27], carbohydrate content [28], fat and protein content [29], amyllopectin [30], food processing and cocking [31]. In contrast, mung bean (Vigna radiate) is well known to have a low glycemic index ranging from 25-31 [32]. However, other studies have focused on controlling high glycemic index by mixing with low-viscosity fibre [33], steaming process [34], mixing high and low glycemic indices [35] polishing process [36] and cooling cooked rice [37].

The current study was designed to assess the glycemic index using a mixed meal of white rice with mung bean at different mixing ratios. A total of 25 volunteers aged between 18 – 22 years were subjected to this test.

2. Materials and Methods

It was well known that in the case of measuring glycemic index in foods, 50 g of carbohydrate should be applied as it has been used in various works [38][39][40][41]. So, in the current work similar weight (50 g) of carbohydrate was utilized as a reference weight and five treatments were prepared where the first was 50 g from white rice (100% rice), the second was mixed of 37.5 g white rice and 12.5 g mung bean (75% white rice and 25% mung bean), the third was 25 g from both white rice and mung bean (50% each of rice and mung bean), the forth was 12.5 g white rice and 37.5 g mung bean (25% rice and 75 % mung bean) and the fifth was 50 g mung bean (100% mung bean) as shown in Table 1.

Table 1: Total nutritional value for every treatment was summed up to approximately 50 g carbohydrate.

| Prepared Meal                      | Total Carbohydrates (g) |
|------------------------------------|-------------------------|
| Rice only (100%)                   | 50 g from the rice       |
| 75 % Rice + 25 % Mung bean         | 37.5 g from rice + 12.5 g from mung bean |
| 50 % Rice + 50 % Mung bean         | 25.0 g from rice + 25.0 g from mung bean |
| 25 % Rice + 75 % Mung bean         | 12.5 g from rice + 37.5 g from mung bean |
| Mung Bean only (100%)              | 50 g from the mung bean  |

Nutrition values of total carbohydrate, available carbohydrate, fibre, protein and fat were determined for each treatment using the method described by Merrill and Watt [42]. A total of 25 random volunteers aged between 18 – 22 years were subjected to this test and divided into 5 groups where each group has 5 volunteers. Each volunteer in each group was given only one 100 g cocked meal as explained in Table 2 above after being fasting from 09:00 PM on the previous evening before the examination. Meals were given to the examined voluntaries from 07:00 AM to 08:00 AM on random days and consumed within 15 min. The blood glucose of each volunteer was measured at 30, 60, 90,120,150, and 180 minutes using the glucocard-01 device.

The GI was defined as [43]

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GI = \frac{\text{Incremental area under blood glucose response curve(IAUC)}}{\text{corresponding area after equicarbohydrate portion of a reference food(rice)}} * 100
\]

IAUC (the incremental area under the curve) of each test food (rice plus lentil) and mean IAUC for the initial two reference foods (rice) were calculated for each person. When the percentage change of the initial two reference foods IAUC was more than 25%, the subject took reference food the third time and the mean IAUC of the closest two values was used as the reference [44].
3. Results and Discussion

Total carbohydrate, available carbohydrate, fibre, protein, and sugar contents in the examined meals are given in Table 2.

Table 2: Examined meal samples and their nutrient characteristics

| Examined Characteristics | Rice only 100% | 75% Rice + 25% mung bean | 50 % Rice + 50 % mung bean | 25% Rice + 75% mung bean | Mung bean only 100% |
|--------------------------|---------------|--------------------------|----------------------------|--------------------------|---------------------|
| Total carbohydrates (g)  | 50.00         | 49.49                    | 49.89                      | 49.99                    | 50.16               |
| Available carbohydrates (g) | 49.19        | 45.53                    | 42.69                      | 39.63                    | 36.60               |
| Fibre                    | 0.81          | 3.96                     | 7.20                       | 10.36                    | 13.56               |
| Protein                  | 4.4           | 8.29                     | 12.14                      | 15.98                    | 19.91               |
| Fat                      | 0.41          | 0.51                     | 0.61                       | 0.70                     | 0.80                |

For total carbohydrate, all examined samples had values ranging from a minimum of 49.49 g in the meal of 75% white rice and 25% mung bean to 50.16 g in only mung bean meal which that all these values were theoretically equivalent to 50 g.

In the case of available carbohydrates, the tested meal samples gave a value varying from a minimum value of 36.60 g in mung bean meal to a maximum value of 49.19 g in the only rice meal. In contrast, fibre content was varied from 0.81 g in only rice meal to 13.56g in only mung bean content was varied from 0.81 g in only rice meal to 13.56g in the only mung bean. For protein content, the meal of only rice had the minimum value (4.4 g) whereas, mung bean had the maximum content of 19.91g. For fat content, it was found that rice meal had the minimum value which was 0.41 g but mung bean showed the highest fat content which was 0.80 g (Table 2, Figure 1, A, B, C, D and E).

Blood sugar (glucose) measured at various times in examining treatment volunteers is given in Table 3. It seems very clear that mean values of blood sugar measured after 30, 60, 90, 120, 150 and 180 minutes have shown an almost similar pattern of response where the highest mean values were found in all volunteers who have eaten only white rice meals whereas the lowest mean values were recorded in those volunteers who had only mung bean meals Table 3.

After 30 minutes, the highest mean value (127 ± 3.5) was recorded in those volunteers who had only white rice meals whilst the lowest mean (117 ± 3.0) measured in those having only mung bean meals (Figure 2.A). These highest and the lowest mean values after 60 minutes were 144 ± 3.9 and 138 ± 3.4 for rice and mung bean respectively (Figure 2.B). Also, after 90 minutes, the mean blood sugar was 146 ± 4.4 in individuals given only rice meals and 130 ±3.9 to those who had only mung bean meals (Figure 2.C). Whereas after 120 minutes, the highest and the lowest mean values were 118 ± 3.2 and 102 ± 2.0 in those who had only white rice and mung bean respectively (Figure 2.D). After, 150 and 180 minutes, these highest mean values have been found to be 95 ± 2.2 and 87 ± 1.9 respectively, in people having only white rice meals while the lowest mean values were 84 ± 1.6 and 80 ± 2.2 were recorded in volunteers who had only mung bean meals (Figure 2. E and F).

Apparently, the highest mean values of blood sugar in all examined were found after 90 and 60 minutes, followed by those mean values recorded after 30 and 120 minutes respectively, while the lowest mean values were measured after 180 and 150 minutes respectively (Figure 3).

In the case of glycemic index, the current study has found that the highest mean value was 100 ± 2.85% and recorded in those volunteers who had only white rice meal while the lowest mean value was 20 ± 1.00 % in those whom were fed by only mung bean meal (Figure 4). In addition, those people fed by a mixture of white rice and mung bean at various ratios gave a mean value of 95 ± 3.20 %, 80 ± 3.15% and 55 ± 1.12% is fed by 75 % rice + 25 % mung bean, 50 % of both rice and mung bean and 25 % rice + 75 % mung bean respectively (Figure 4).
Figure 1: Examined meal content; A. total carbohydrate, B. available carbohydrate, C. fibre, D. protein, E. fat.
Table 3: Blood sugar content mg/l (glucose) measured by examining volunteers were given different meals at various times.

| Treatment               | Mean ± Sd                  |
|-------------------------|----------------------------|
|                         | 30 min. | 60 min. | 90 min. | 120 min | 150 min | 180 min | G.I |
| Rice only (100%)        | 127±3.5 | 144±3.9 | 146±4.4 | 118±3.2 | 95±2.2  | 87±1.9  | 100±2.85 |
| 75 % Rice + 25 % M. B. | 124±2.8 | 143±3.6 | 136±4.0 | 115±2.8 | 91±2.4  | 83±2.3  | 95±3.20  |
| 50 % Rice + 50 % M. B. | 122±3.0 | 142±4.4 | 134±3.2 | 110±2.5 | 89±1.7  | 83±2.8  | 80±3.15  |
| 25 % Rice + 75 % M. B. | 120±2.6 | 140±4.8 | 131±3.6 | 106±2.4 | 86±1.8  | 81±2.0  | 55±1.12  |
| Mung Bean only (100%)   | 117±3.0 | 138±3.4 | 130±3.9 | 102±2.0 | 84±1.6  | 80±2.2  | 20±1.00  |

Figure 2: Mean blood sugar in the examined sample after 30 minutes (A), 60 minutes (B), 90 minutes (C), 120 minutes (D), after 150 minutes (E) and after 180 minutes (F).
In the current study, white rice was regarded as a reference food [44]. Single and mixed meals of white rice and mung bean were compared for blood glucose impact and glycemic index of each mixed food meal to select combinations of rice and mung bean that could reduce postprandial glucose response could contribute to preventing and clinical health care.

Long grain white rice and mung bean grains ranked as high and low glycemic index, respectively [45][46]. The glycemic index of each treatment was evaluated, based on white rice as the reference, has revealed that white rice meals had the highest impact on blood glucose level and the quickly coming down. At the same time, other mixtures stayed relatively stable for long enough then come down. It was found that mung bean the mung bean component in the meal mixture increased as blood glucose response decreased and was increased as blood glucose response decreased and has quite come down. Elevated glucose levels for a long steady time may contribute to the well-known macrovascular (cardiovascular disease, peripheral vascular disease) and microvascular (nephropathy, retinopathy, and neuropathy) complications associated with type 2 diabetes [47].

The glucose-lowering effect of mung bean may be due to the probable effect of low glycemic index diets on glucose metabolism, including reduction of glucose poisoning or effect of great amounts of glucose on the destruction of pancreas beta Cells, reduction of proteins and key enzymes glycosylation which are responsible for the metabolic process [48].

Apparently, glycemic index values (Table 3) have revealed that mixing mung bean with rice had has significantly affected the glycemic index. It is well known that white rice is classified as a high GI meal.
while mung bean classified as a low GI meal [46,49] and this means that more mung bean addition will result in more glycemic index decreasing and only mung bean meal containing the lowest glycemic index had higher contents of protein, fat and fibre. Mung bean and rice had different constituents attributed to changes in the glycemic index of the mixture meal. Mung bean had low glycemic index values that lower the effect when consumed with rice as a mixed meal. The mechanism of glycemic index lowering (anti-hyperglycemic effect) may be due to many reasons.

The glycemic index has a lower effect when rice is consumed as a mixed meal (anti-hyperglycemic effect) where this may be due to a delay in gastric emptying, through animal studies revealed that mung bean could activate gluconeogenesis and induce glycogenesis (formation glycogen from glucose) in the liver after a fasting state. It could also inhibit glycolysis in muscles [50].

The obtained results (Table 2) have shown increased total fibre content in the mixture compared to rice. The increasing soluble fibre in the mixture may lead to a decrease glycemic index [51]. The extent to which the glycemic index could be affected by food's dietary fibre content debatable, [52]. It was found that there was a positive correlation between insoluble (r = 0.584), but not soluble fibre and glycemic index. However, soluble fibbers have an effect on postprandial glycaemia [53]. In terms of fibre viscosity, the more viscous the fibre is, the higher its effect on decreasing the glycemic index of the meal [54].

4. Conclusions
Rice is a starchy diet with its nutrients and fibre stripped away, causing hyperglycaemia as a lonely rice meal. Mixing mung bean with white rice improves the meal nutritive value due to its component of protein, fat, fibre and micronutrients and reduces risks due to the capability of blood glucose spiking control.

We encourage more mung beans. Less white rice as a replacement in meals as lifestyle habits for better health.

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