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Effect of Rice and Lentil as Mixed Meals on Postprandial Relative Glycemic Response in Healthy Adults

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Abstract: ***The objective of the experiment was to compare predicted with measured GI of different rice-lentil mixed Iraqi meals. Rice alone, Lentil and combination mixtures included to test the effect of Lentil increments on GI. All Twelve subjects fed 50 (g) load of rice, lentil and combinations .Subjects with ages ranged between 18-20 years and their mean body mass index was 23.42 kg /m2.. None of the subjects had impaired glucose tolerance. The clear conclusion was, lentil additions companied Rice replacement in the meal gave better GI. It means that mixing Lentil with rice is a healthy habit.***

1. Introduction

Rice (oryza sativa L.) as a polished grain is a staple food for more than half of the world's population and more than for most Iraqi people. Polished rice grain consists of about 90 percent carbohydrate (mostly starch), 8 percent protein and 2 percent fat (1). White rice (polished) is a source of mineral like magnesium, phosphorus, manganese, selenium, iron, folic acid, thiamine and niacin .Polishing process eliminate most fiber and fat content which leading to raise the net carbohydrate grain content. White rice classified as medium to high glycemic index (2) depending on many factors like Amylose vs. Amylopectin (resistant starch), polishing processes and variety features. Rice carbohydrate induce more insulin to impact the blood sugar spike then doubling the insulin spike after ingestion, it means that rice feeding affect blood sugar levels so far. . Carbohydrates is a macronutrient as energy source not a toxin itself, but excessively consuming for long time as a life style manner, would have a negative effect on health through induce "glycation" a biochemical reaction leading for many chronic disease . On the contrary, limiting carbohydrates throw dietitian plans (i.e., calorie restriction) slows aging and age-related diseases in most species…The pro-aging effect of glucose spiking on life span correlated with an increase in reactive oxygen species (ROS) the anti-aging effect of calorie restriction which done through plans dietitian lead to lowering (ROS) production then protect human body from many negative impact on human body biomarkers i.e. high blood pressure , high blood triglycerides that increase the risk of heart disease (3), low HDL levels (good cholesterol) a risk factor for heart disease as declared in the Third National Health and Nutrition Examination Study (4), increase hunger (5), vasoconstriction, inhibited fat burning (obesity), and reduce production of glycerol substrates to make glucose. the sheer fact that two-thirds of Iraqi adults are overweight and obese (6) and probably well over two-thirds of the Iraqi an adult population, needs to be very careful about eating foods that will raise their insulin levels—as starches like rice . Iraqi staples include rice lentil male as a habit not as a healthy style and very little knowing about improvements.

To explore precisely how much mixing pattern of rice-lentil affect blood glucose fluctuation to attain for healthy mixed staple, we used a dietitian tool "Glycemic Index" GI is a rating of how individual staple raise blood sugar to test what happen. The sum daily carbohydrate is one way to manage blood sugar levels. Consequently, eating lentil and rice that have a lower glycemic index than eating rice lonely can help keep blood sugars lower.

Generally mixed meal have less carbohydrates with a less GI causing break down slowly in gut. This causes blood sugar to gradually raise to a moderate level and stay relative stable for long enough. Clinical study proved that mixing beans and rice meals lowered blood sugar, compared to rice alone. Researches had demonstrated that beans regulate a number of metabolic processes, and it's been suggested that they may similarly to the oral diabetes medication acarbose function and may share a common mechanism with metformin medication (7) One of the most surprising suggestions to come from bean research is that consuming beans regularly may have a preventive effect similar to Tamoxifen drug (7) a medication prescribed to premenopausal.. Eating lentil and rice in combination offers some health benefits over eating rice only due to the addition of complementary protein increasing dietary fiber (DF) which contributes to slowing down the release of sugar from the digested food into the bloodstream (8), Other benefits are nutrients including folate, phytochemicals they provide are saponins, phytic acid, phenolic compounds, and lectins, that helps feel full after eating, promotes digestive regularity

GI values of white rice varieties were shown to be higher (in the range of 70 –77) compared with legumes, which have GI values from 50 -87 and 10 -70, respectively (9).

The objective was to compare predicted with measured GI of different rice-lentil mixed Iraqi meals. However, the determination of the Glycemic Index (GI) for mixed meals serves as a dietetic tool in planning to reinforce the benefits of low GI meals and decrease the physiological impact of high GI meals.

2. Materials and Methods

All used grains in experiment were packed with nutrition information label as shown below.

Table 1: Nutritional value per 100 gm for rice and lentil grain (dry weight)

` Component	Rice	Lentil
Total carbohydrate (CHO)	80	63
Dietary fiber	1.3	10.7
Protein	7.1	25
Fat	0.66	1
Sugar	0.12	2
Water	12	8.3

All subjects fed 50 (g) carbohydrate load of white long grain rice (T1) as a reference food (10), and each of all of other treatments were carried out randomly through the next days (T2, T3, T4, T5) as shown in table (2) .

Table 2: Meal characteristics for different treatments (g)

Characteristics	T1	T2	T3	T4	T5
Total weight	62.5 0	**66.72**	70.93	75.08	79.63
Rice (R)	62.5 0	46.88	31.25	15.56	0.00
Lentil (L)	0.00	19.84	39.68	59.52	79.63
Total carbohydrate	50.00	49.49	49.89	49.99	50.16
Available CHO	49.19	45.53	42.69	39.63	36.60
Fiber	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
Sugar	0.07	0.46	0.83	1.21	1.59

T1 mean RL 4:0 50 gm carbohydrate from rice only.
T2 mean RL3:1 37.5 gm carbohydrate from rice + 12.5 gm carbohydrate from lentil.
T3 mean RL 2:2 25 gm carbohydrate from rice + 25 gm carbohydrate from lentil.
T4 mean RL 1:3 12.5 gm carbohydrate from rice +37.5 gm carbohydrate from lentil.
T5 mean RL 0:4 50 gm carbohydrate from lentil only.

Total nutrition value for every treatment was summed up to approximately 50 g carbohydrate (10).

Twelve subjects with ages ranged between 18-20 years and their mean body mass index was 23.42 kg /m2. Exclusion criteria included regular use of prescription drugs, allergies to food items tested in the study. None of the subjects had impaired glucose tolerance. They consumed a white rice serving containing 50 g of carbohydrate as reference meal and three mixed meals and lentil serving lonely .Each serving containing 50 g of carbohydrates as test meals on separate days. Their blood glucose levels were measured every 30 min over 150 min. following the test food consumption. With digital device capillary blood glucose was obtained through finger prick using a glucometer (GLUCOCARD 01) subjects continued their usual activities and were advised to follow their routine dinner practices during the study and in the washout period. However, they were requested to refrain from smoking during the study period.

Dietary intake during the study period was ascertained with a validated food frequency questionnaire at baseline, and 24-h dietary recalls were collected for 6 consecutive days (pretest day and 5 test days) during the intervention period to ensure compliance with the study and to record foods consumed for dinner, which was not part of the tests.

Subjects started fasting from 09:00 PM on the previous evening before examination. Meals were given to the subjects from 07:00 AM to 08:00 AM on random days. Foods were consumed within 15 min. The subjects carried out self-monitoring blood glucose in director watching Six times in total: at fast, 30, 60, 90, 120 and 150 min.

The GI was defined as (11)

$$GI = \frac{\text{Incremental area underblood glucose response curve(IAUC)}}{\text{corresponding area after equicarbohydrate prtion of a reference food(rice)}} * 100$$

IAUC 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 mean IAUC of the closest two values was used as the reference (12) .

3. Results and Discussion

In the current study, white rice was regarded as a reference food (12). Single and mixed meals of white rice and lentil were compared for their blood glucose impact and GI of each mixed food meals to select combinations of rice and lentil that could reduce postprandial glucose response could contribute to preventive and clinical health care.

Long grain white rice and lentil grains ranked as high and low glycemic index respectively (13) GI of each treatment was evaluated based on white rice as the reference (Fig. 1) revealed white rice meals have the highest impact on blood glucose level and the quickly coming down, while other mixtures stay relative stable for long enough then coming down, as lintel component in meal mixture increase as blood glucose response decrease and have quite coming down. Elevated glucose levels for 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 (14).

The glucose-lowering effect of lentils may be due to probable effect of low GI diets on glucose metabolism, including reduction of glucose poisoning or effect of great amounts of glucose on destruction of pancreas beta Cells, reduction of proteins and key enzymes glycosylation which are responsible for metabolic process (15).

For diet education among Iraqi population, blood glucose level inefficient tool, thus we have to detect GI as a tool, for this purpose to consume rice as a staple food with safe meal structure and sustainable health.

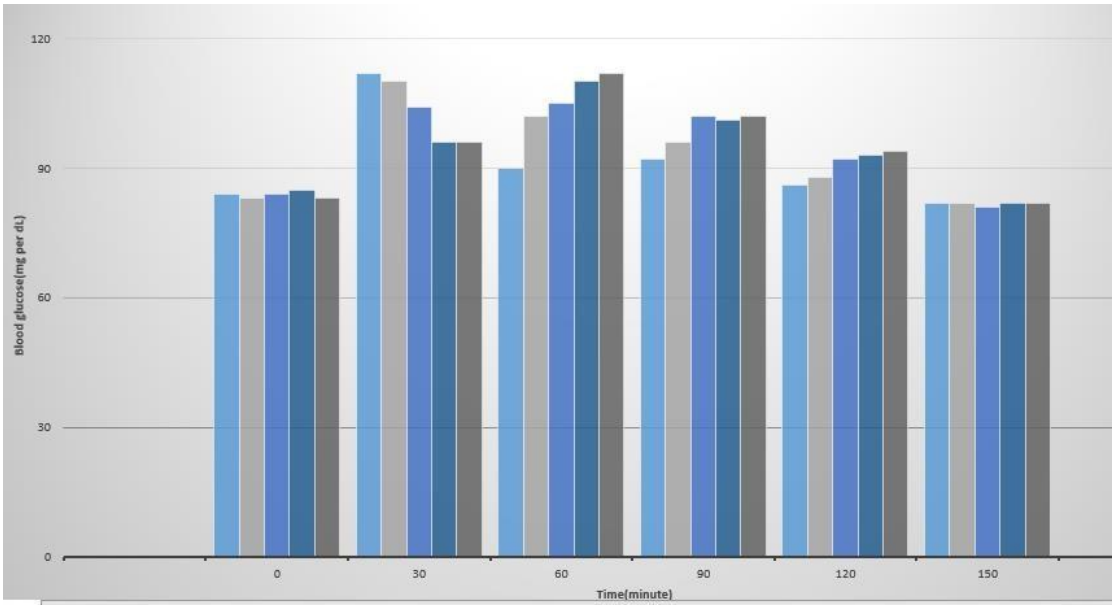

Figure 1: Influence of different mixed meals on postprandial blood glucose

In the current study, generally glycemic index values as indicated in (table 3), revealed mixing lentil with rice had a huge influence on GI. We know that rice classified as a high GI meal, lentil classified as a low GI meal (16)., more lentil addition means more GI decreasing and the treatment T4 had the lowest GI, the higher content of protein, fat and fiber. Lentil and rice had different constituents attribute to change GI of mixture male. Lentil had low GI values and GI lowering effect when consumed with rice as mixed meal. The mechanism of

GI lowering (antihyperglycemic effect) may be due to many reasons as will talk over.

Macronutrients stimulate the release of several gut peptides different levels. Protein and fat are particularly induce gut peptide release despite a small glucose impact. Thus, the insulin response to a carbohydrate food varies with the amount of fat, protein, or both, with which it are ingested. (17, 18) Lentil is a source for some storage proteins that are described as biologically active proteins. These proteins have been historically referred to as ‘‘antinutritional’’ compounds such as lectins and protease inhibitors (PIs) this is one of many probable reason for GI lowering effect (19). ALL treatments had different macronutrients although had the same amounts of total carbohydrates.

Table 3: Glycemic index values and other related variables

Meal	GI (Mean ± SEM)*	Serving size (g)	Available CHO **(g)**	Energy (kcal.)
T1	100±2.85	62.0	49.19	218.26
T2	95± 3.20	66.72	45.53	219.87
T3	80± 3.15	70.93	42.69	224.81
T4	55± 1.12	75.08	39.62	228.74
T5	20± 1.00	79.03	36.60	233.24

*All values are means ± standard error of the mean (SEM).

GI lowering effect when consumed with rice as mixed meal (antihyperglycemic effect) may be due to a delay in gastric emptying, through animal studies revealed that lentil could activate gluconeogenesis and induce glycogenesis (formation glycogen from glucose) in the liver after a fasting state. It could also inhibit glycolysis in muscles (20).

Structure such as particle size and Starch type affect GI value, changing in proportion amylose to amylopectin in grains, affect the GI because lentil and rice have different starch type (21).Amylose is a linear molecule have D-glucose linked in an (alpha1-4) fashion. Amylopectin has both (alpha1-4, 1-6) fashions. Branched –starch molecules of amylopectin more easily hydrolyzed in gut than did single-strand amylose. More easily hydrolyzed mean more quickly raising GI.

Results in table (2) referred to increase total fiber content in mixture compare to rice fiber content. Increasing soluble fiber in the mixture may lead to decrease GI (22). The extent to which the GI could be affected by the dietary fiber content of the food is debatable, (23, 24) found a positive correlation between insoluble (r = 0.584), but not soluble fibers and GI. However, soluble fibers have an effect of postprandial glycemia (25). In terms of fiber viscosity, the more viscous the fiber is, the higher is its effect on decreasing the GI of a meal (26).

Lentil have high phytate levels which may bind to calcium, thus reducing it as a cofactor for α-amylase enzyme activity, causing low starch digestibility and producing relatively small blood glucose rises after consumption (27).Generally phytochemicals and phytonutrientsare associated with improvements in glycemic control .. By cooked lentil has approximated to acarbose, a popular diabetes medication

The Results may serve as valuable data for health professionals, including dieticians, to have a good glycemic management in overweight and obesity and good health.

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