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Estimation of *In Vitro* Starch Digestibility (IVSD) in the Fermented Rice and Ragi Based Products

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ABSTRACT

India leads the world with largest number of diabetic subjects earning the dubious distinction of being termed the "diabetes capital of the world. In India, Hyderabad from the southern region is the diabetic capital of India. Dietary management of diabetes involves the reduction of postprandial hyperglycaemia and good glycemic control. Rice and ragi dosa may possibly be considered an alternative to other fast digesting cereal sources; However, there are very little information on the in vitro starch digestibility of ragi dosa, rice dosa and similar cereal-pulse breakfast preparation. The study was undertaken to measure in vitro starch digestibility of the two products rice dosa and ragi dosa. The in vitro starch digestibility was measured in maltose released per 100 mg of sample. Fermentation increased the starch digestibility of rice and ragi dosa. The two sample t test implied a significant difference ($p=0.001^{**}$) between the IVSD of Rice dosa and Ragi dosa. The in vitro starch digestibility for ragi dosa (14.55) was found more than that of rice dosa. The reason attributed concord with a study where ragi has reportedly high amount of rapidly digestible starch and less slow digestible starch compared to rice. In addition, smaller grain size of ragi provided greater surface area to be acted upon by enzymes thus results in easy digestion and absorption. So, the consumption of fermented rice and ragi products consistently over a period of time can increase the post prandial blood glucose levels and their inclusion in the baskets of diabetics calls for more concrete research.

Key words: *In Vitro, Digestibility, Diabetes, Ragi, Fermentation.*

INTRODUCTION

The shadow of diabetes is rising all over the world due to population growth, aging, urbanisation and an increase of obesity and physical inactivity. Diabetes is fast gaining the status of a potential epidemic in India with more than 62 million diabetic individuals currently diagnosed with the disease[10]. The International Diabetes Federation (IDF) estimated the total number of people in India with diabetes around 50.8 million in 2010 which would rise to 87.0 million by 2030[15]. According to National Urban Diabetes Survey, Hyderabad was found to be diabetic capital of India.

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Hyderabad, a fast growing IT hub, is one of the major contributors to country's diabetic table, with one in every six persons a diabetic. The neighboring cities like Chennai and Banglore with similar lifestyle represents less diabetic cases as compared to Hyderabad[14].

Poor glycemic control, a factor that has been observed in the Indian diabetic population[23], is responsible for micro- and macrovascular changes that present with diabetes, and can predispose diabetic patients to other complications such as diabetic myonecrosis[17] and muscle infarction.

The main approaches in the management of diabetes such as dietary modification, weight control and regular exercise with diet are the sheet anchor to address this problem. Because the risk of developing long term complications can be significantly minimized by appropriate glycemic control, food ingredients which can reduce postprandial glucose in persons with and at risk of diabetes would be valuable.

Cereals and legumes play imperative role in human diets. The use of cereal- legume blends is also deep-seated in all societies. It provides an adequate nutrient profile[19] including an improved amino acid pattern. Various processing and cooking techniques have been reported to decrease the level of antinutrients. Texture, endosperm and cooking conditions have been shown to have a considerable effect on *in vitro* digestibility of starch and protein in the cereals[9]. Fermentation is one of the processes that reduces the level of antinutrients[12,22] in food grains and enhances the starch digestibility, protein digestibility[7], improves amino acid balance[3] and overall nutritive value[1,5].

In vitro digestibility of carbohydrates plays an important role in the rapid assessment of the quality of carbohydrates present in foods and relates with how a given food is likely to behave *in vivo*, in terms of the rate and extent of sugar release from available carbohydrates, by mimicking physiological processes occurring in the mouth, stomach and small intestine. The digestibility of starch measured *in vivo* is a time- demanding, costly process requiring many human or animal subjects with specific attributes.

Since there is no human or animal subject dependence on the measurement of *in vitro* starch digestion, investigation of *in vitro* digestibility is a time- and cost-efficient means for analyzing the carbohydrate digestibility as a replacement for the glycemic indices is an increasingly researched topic[6].

The sedentary lifestyle and fast food consumption among the new generation besides the consumption of more quantity of rice can be the possible reasons for the increase of diabetic cases in South India. Since Hyderabad is considered as capital of diabetic, Rice and Ragi dosa, a widely consumed fermented food item in South India may possibly be considered an alternative to other fast digestible cereal sources in forming the food basket of diabetics. However, there is very little information available on the *in vitro* starch digestibility (IVSD) of Ragi dosa and Rice dosa and similar cereal-pulse breakfast preparation. Having known about IVSD will help in prediction of glycemic index which in turn categorize the foods into low and high glycemic value. This would help nutritionists to organize the food basket for diabetics.

So, the current study was focused on Assessment of *in vitro* starch digestibility of Rice dosa and Ragi dosa, a breakfast item widely consumed in south India.

MATERIAL AND METHODS

Materials

Black gram dhal, rice, ragi, salt, cooking oil and other ingredients required for the preparation of Dosa were obtained from the local market in Rajendranagar, Hyderabad.

Table 1: Composition of Rice, Ragi and blackgram dhal

Type of Dosa/ ingredients	Rice	Ragi	Blackgram	Total Quantity	Available CHO
Rice Dosa	47 gm	-	23.5gm	70.5gm	50 gm
Ragi Dosa	-	49 gm	24.5 gm	73.5 gm	50 gm

Method

The ratio of Rice and black gram dhal was taken as 2:1 and the same ratio was used for Ragi and Blackgram dhal. The Composition of Rice, Ragi and Blackgram dhal is given in the Table 1.

Method of preparation of Rice Dosa

Soak Rice and black gram dhal in water for 5-6 h

↓

Grind the soaked Rice and Black gram dhal with water

↓

Keep the ground batter for fermentation for 6-7 h

↓

Prepare the Dosa by smearing a very little quantity of oil.

Fig. 1: Flow chart preparation of Rice Dosa

The same procedure was followed to prepare ragi dosa.

***In vitro* Starch digestibility (IVSD)**

The method given by Singh *et al*[21]., was followed to estimate in vitro starch digestibility. 50 mg of cereal flour was taken in a test tube and mixed with 1 ml of 0.2 M phosphate buffer (pH 6.9). Pancreatic *alpha amylase* (0.5 mL) was added to the sample and incubated at 37º C for 2 h. After the incubation period 2 ml of 3, 5-DNS reagent (prepared by dissolving 200 mg crystalline phenol, 1 g 3,5-dinitrosalycylic acid and 50 mg sodium sulphite in 1% NaOH solution) was added immediately. The mixture was heated for 5-15 min in a boiling water bath. After heating 1.0 mL of 40% K-Na-Tartarate solution was added in the test tubes and allowed to cool at the room temperature (25 ºC). Thereafter solution was made up to 25 mL with distilled water and filterd prior to measurement of the absorbance at 550 nm. A blank was run simultaneously. A standard curve was prepared using maltose. Values were expressed as mg maltose released per 100 mg of sample.

RESULTS AND DISCUSSIONS

***In vitro* Starch Digestibility of Rice dosa and Ragi Dosa**

The values for IVSD of rice and ragi are given in Table 2 and presented in Figure 2. The test was conducted for six consecutive days to find changes in the results due to variability in preparation and the mean was taken as accurate estimation of *in vitro* starch digestibility. Two sample t-test was used to ascertain the significant difference between IVSD of Rice dosa and Ragi dosa and it was found that there was a significant difference (0.001**) at $p < 0.05$ level.

The *in vitro* starch digestibility for ragi dosa (14.55) was found more than that of rice dosa (11.78). The reason for higher value concorded with a study where fermented ragi had reportedly high amount of rapidly digestible starch and less slow digestible starch compared to fermented rice[20]. The smaller grain size of ragi provided greater surface area to be acted upon by enzymes thus results in easy digestion and absorption.

Table 2: *In vitro* starch digestibility mg maltose releases per 100 mg sample

***In vitro* starch digestibility (mg maltose released per 100mg sample)**		
Days/ Products	Rice dosa	Ragi dosa
1	12.9	16.3
2	11.2	14.2
3	10.7	13.8
4	11.5	14.6
5	12.6	15.5
6	11.8	12.9
Mean ± SD	11.78 ± 0.83	14.55± 1.21
t value	4.59	
p value	0.001**	

Fermentation increased the starch digestibility of rice and ragi dosa but the time it had undergone fermentation was only for 5-6 hours. Alka *et al*[2]., reported that with increase in fermentation time, the *in vitro* starch digestibility of sorghum, maize and pearl millet increased and was reported highest after 28 h of fermentation. This increase may be due to the fact that fermentation led to changes in the endosperm protein fractions and this makes starch more accessible to the digestive enzymes. Elkhalifa *et al*[7]., reported that sorghum flour led to an increase in the IVSD from 34.55 to 56.69% after 28 h fermentation.

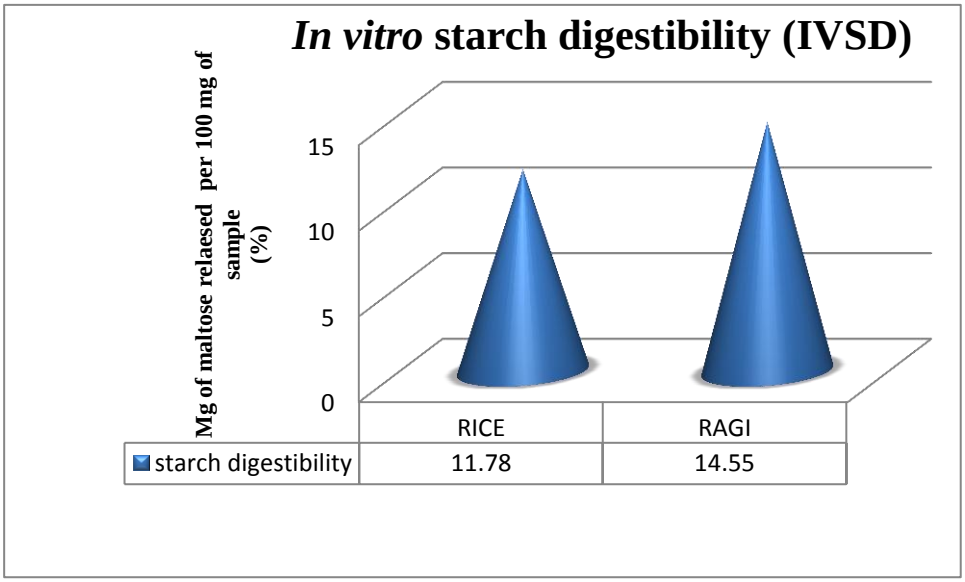

Fig. 2: *In vitro* starch digestibility of Rice dosa and Ragi dosa

Mohana *et al*[11]., elicted in his study that a high amylose content was found in rice starch (25%) compared to ragi starch (22%) and there are various studies which has reported an inverse relation between amylose content and *in vitro* starch digestibility[13,18]. So, the high value of amylose comtent in rice significantly reduced its *in vitro* starch digestibility compared to ragi.

Whole grains like millet may have health promoting effects equal to or even in higher amount than fruits and vegetables and have a protective effect against insulin resistance, heart diseases, diabetes, ischemic stroke, obesity, breast cancer, childhood asthma and premature death[4]. The higher value of fermented ragi dosa (millet based product) led to increase IVSD which related to high

glycemic index, this, resulting in increased post prandial blood glucose levels.

The malted and fermented *ragi* flour are extensively used in preparation of weaning food, instant mixes, beverages and pharmaceutical products[16] but more concrete research is needed to reach to a conclusion about role of rice dosa and especially ragi dosa (fermented products) in lowering the post prandial glucose levels and prevent the people at risk of diabetes to get into more worsen condition.

CONCLUSION

The *in vivo* procedure used to determine GI values of food is very laborious and time consuming. Thus several *in vitro* methods had been developed mainly by focusing on the carbohydrate sensitivity to the action of digestive enzymes.

Rice and Ragi dosa, the fermented food products, which are widely consumed in South region which is the diabetic hub of India, reported a fair amount of rapidly digestible starch and less slow digestible starch content in the prepared dosa. Ragi dosa was found to have more *in vitro* digestibility compared to rice dosa. So, inclusion of fermented ragi products in the food basket of diabetics and at risk of diabetes is still in the grey region and requires more concrete research to get back to the white region.

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