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Use of Sensory Evaluation as a Tool for Determining Supplementation Dose of *Jungle Jalebi* (*Pithecellobium Dulce*) Fruit Powder (JJFP) to Type-2 Diabetic Patients

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ABSTRACT

In human interventions, the supplementation dose of any therapeutic food formulations is primarily determined based on body weight and the supportive evidence provided in the review of the literature. The long-term consumption of such newly designed therapeutic food formulations mostly depends on their sensory parameters, the amount of edible dose, and the associated body response of the individual. In traditional Indian wisdom, the use of *Jungle Jalebi* (*Pithecellobium dulce*) fruits as a potential hypoglycemic agent is well established and also proved by several pharmacological analysis animal model studies. But there is still a paucity of scientific evidence for human trials in the treatment of type 2 diabetes. Thus, in this study, sensory evaluation was used to determine the dose *of Jungle Jalebi* fruit powder (JJFP) for long-term supplementation in type 2 diabetes. The findings of the present study suggest that, on the basis of the responses to the questionnaire, a judicious dose for long-term human supplementation can be determined, which can be taken by respondents with ease.

Key words: Dose determination, Therapeutic food formulations, Sensory evaluation

INTRODUCTION

Pithecellobium dulce (*Jungle Jalebi*) fruits have immense therapeutic potential due to the presence of several phytonutrients and active pharmacological agents. It is a very well-known hypoglycemic agent in Indian pharmacopeia, but its uses are still limited due to localized cultivation and consumption (Sharma and Mehta,2013). Along with the traditional wisdom of India, several pharmacological analyses and animal modal studies also prove that the *Jungle Jalebi* (*Pithecellobium dulce*)fruits can be used as an effective hypoglycaemic agent (Pradeepa and Mohan*.,* 2013; Raju and Jagdeeshwar, 2014; Sukantha*et al.,* 2016). In animal model studies, the suggested effective doses for supplementation were 100, 200, and 300mg/kg body weight as minimum, mild and maximum doses, respectively (Megala and Geetha, 2012). The processing of Jungle *Jalebi* (*Pithecellobium dulce*) fruits in effective food formulations (sundried food powder) may act as a cost-effective and suitable therapeutic tool for human supplementation due to its short fruiting season (April-June). However, there is still a paucity or lack of scientific evidence to assess the effective supplementation dose

of *Jungle Jalebi* (*Pithecellobium dulce)* fruit as an effective agent to treat diabetes in humans.

In human interventions, the determination of the supplementation dose of any therapeutic plant food supplements is primarily based on body weight and the supportive evidence provided in the review of the literature (Floyd *et al*., 2022). Although the long-term consumption of such formulations mostly depends on their sensory parameters, the design of food powders requires a study of their sensory parameters so that their overall acceptability can be determined on the basis of certain organoleptic properties and their mouthfeel. Along with sensory evaluation, the amount of edible dose also requires assessment of any changes felt in digestion, body response, and behaviour after consumption of the newly designed therapeutic food formulations. Assessment of all these parameters before the supplementation of any therapeutic food formulations may provide certainty for their long-term consumption. The amount of the daily supplementation dose must be judiciously decided on the basis of responses given by trained or semi-trained professionals and the participants of the study. Thus, this study was planned to use sensory evaluation as a tool for determining the effective dose of JJFP for long-term supplementation in type-2 diabetics.

MATERIALS AND METHODS

Development of Jungle Jalebi fruit powder (JJFP)

The raw fruits of *Jungle Jalebi* were purchased from the local market of Udaipur city and processed to develop *Jungle Jalebi* fruit powder (JJFP) by using pre-standardized methods given by Shukla (2018) and Joshi and Joshi (2019) or their modifications as per need.

Dose determination by sensory evaluation

To determine the dose for long-term supplementation, a structured questionnaire was designed to obtain information on the various sensory aspects of the developed JJFP as follows:

Organoleptic properties: Information related to the organoleptic properties of the developed JJFP, such as colour, flavour, texture, aroma, taste, and overall acceptability was obtained by using a nine-point hedonic rating scale (ISO, 1987). The respondents were asked to fill the following information immediately after consumption of JJFP.

***Mouth and throat feel*:** The participants were also asked to respond about their mouthfeel and throat feel (after two hours of consumption). Mouthfeel included multiple oral sensations like tongue feel, chewability, tongue movement, temperature, wetness, chemical, and after-feel of mouth after consumption (Agorastos *et al*., 2020).

***Changes in digestion, body response, and behaviour*:** To know the side effects of powder supplementation, changes in digestion, body response, and behaviour were also asked in the questionnaire after one day of consumption of the powder.

***Dose determination*:** The respondents were also asked about the amount of JJFP (dose) that can be taken in a single instance or for regular consumption for three months as a functional food powder.

Selection of panel members : The present

study was ethically approved by the Institutional Ethical Committee, MPUAT, Udaipur. And informed consent was obtained from the participants before providing the supplementation dose to them.

The sensory evaluation of the developed JJFP powder done by two groups was designed as follows:

Group I: ***Semi-Trained Panel:*** A panel of fifteen semi-trained individuals was selected from the students and staff members of the College of Community and Applied Science (CCAS), MPUAT, Udaipur. During the selection of panel members, their willingness, knowledge, experience, and sincerity were also considered.

Group II : Diabetic ***Group:*** Fifteen diabetic individuals were selected purposively and were asked to take the developed JJFP powder to assess the feasibility of supplementation.

After considering a review of the literature and the varied body weights of humans, it was decided that 20 g of JJFP powder would be given to each participant. The developed JJFP powder (two ziplock pouches containing 10 g of powder in each packet *i.e.*, 20 g in total) was given to each participant in both groups. They were asked to take the amount of powder as per their convenience and ease and fill out the above-structured questionnaire.

RESULTS AND DISCUSSION

SENSORY EVALUATION

The sensory evaluation of the developed JJFP in terms of organoleptic properties, mouthfeel properties, and dose determination was done by an equal number of normal (N_1=15) and diabetic (N_2=15) individuals aged between 25 to 63 years with an approximately equal distribution of gender.

Organoleptic properties

The mean score of organoleptic properties of developed JJFP powder given by normal and diabetic individuals is presented in Table No. 1. The mean scores of organoleptic properties obtained from diabetic and non-diabetic (normal) individuals showed similar scores with non-significant difference. The obtained mean score for colour, flavour and taste given by both diabetics and non-diabetics is ≥8, corresponding to liked very much. The observed characteristics of the developed JJFP showed a pink-red colour with caramel like flavour and slight sweet taste. The mean score for aroma of developed JJFP is high in diabetics (8.13±1.06) and better than non-diabetics individuals (7.87±1.30) which is in between of liked moderately and very much liked and observed as pleasant. The granular and fibrous texture of the developed JJFP powder showed the lowest mean score for both diabetics (7.87±1.25) and non-diabetics (7.47±1.13) among all the sensory parameters, but it was still in the category of being liked very much. The overall acceptability of the developed JJFP powder was higher in diabetic group (8.47±0.92) as compared to non-diabetic patients (8.13±1.25). Similar to present study, Rao *et al*., (2011) also developed powder from both white and red aryls of *Pithecellobium dulce* fruit and found their excellent acceptability with scores more than eight in sensory parameters such as acceptability, colour, flavour, taste and overall quality.

Table 1: Organoleptic properties of developed JJFP

S. No.	Sensory Parameters	Score by non-diabetics (N1=15)	Scores by diabetic (N2=15)	p value
1	Colour	8.13±0.92	8.33±0.90	0.28NS
2	Flavour	8.13±1.13	8.00±0.93	0.73 NS
3	Texture	7.47±1.13	7.87±1.25	0.36 NS
4	Aroma	7.87±1.30	8.13±1.06	0.54 NS
5	Taste	8.13±1.41	8.47±1.06	0.47 NS
6	Overall acceptability	8.13±1.25	8.47±0.92	0.41 NS

Values are given as Mean ± SD

p value is calculated between score by non-diabetics and diabetics

NS Non-significant

Mouthfeel Properties

The mouthfeel properties of developed JJFP powder reported by normal and diabetic individuals are presented in Table No. 2. For all the mouthfeel parameters, there is a non-significant difference between the responses of diabetic and non-diabetic individuals, except for wetness of the mouth. A significant difference ($p \leq 0.05$) was observed for the wetness of the mouth after eating the JJFP, as diabetics reported normal wetness in the mouth while non-diabetics said they observed no change in their mouth wetness.

A similar number of diabetic and non-diabetic individuals, i.e., 86.66%, reported easy chewability of the developed JJFP powder. More than 50% of participants reported a smooth tongue feel in both the diabetic and non-diabetic groups. During tongue movement, stickiness on the tongue and pasty consistency were reported more in the non-diabetic group (46.67 and 73.33%) as compared to the diabetic group (26.66 and 40%), respectively. In chemical reactions, more than 70% of participants reported no reaction, while the remaining reported a slightly astringent or burning sensation in the mouth. A similar proportion of non-diabetic individuals, i.e., 40%, reported a clean and dry mouthfeel after eating JJFP powder. In diabetics, 80% of respondents reported clean or no mouthfeel after eating JJFP powder. The felt temperature in the mouth was normal for 96.67% of non-diabetic individuals, while 100% of diabetic participants reported a normal or no change in the temperature of the mouth after eating JJFP powder. A total of 60% of non-diabetic individuals reported no change in wetness of mouth, followed by dry (26.67%) or normal (13.33%). In diabetics, approximately a similar proportion of individuals reported normal (53.33%) and dry mouth (46.67%) after eating JJFP powder. Thus, the mouthfeel parameters of the developed JJFP powder are characterized by easy chewability, pasty consistency in the mouth, which tends to stick to teeth, and a slow tongue movement with normal or no change in mouth temperature and wetness followed by a normal and dry afterfeel.

Table 2: Mouthfeel parameters of developed JJFP

S. No.	Mouthfeel parameters	Parameters				Yates *p* value
1.	Chewability	Easy	Average	Hard	None	0.91 NS
	Non diabetics % (N1)	86.66 (13)	6.67 (1)	0 (0)	6.67 (1)	
	Diabetics % (N2)	86.66 (13)	6.67 (1)	6.67 (1)	0 (0)	
	Total % (N)	86.67 (26)	6.67 (2)	3.33 (1)	3.33	1)
2.	Tongue feel	Smooth	Creamy	Sticky	None	0.95 NS
	Non diabetics % (N1)	53.33 (8)	0 (0)	46.67 (7)	0 (0)	
	Diabetics % (N2)	60.00 (9)	6.67 (1)	26.66 (4)	6.67 (1)	
	Total % (N)	56.67(17)	3.33 (1)	36.67 (11)	3.33 (1)	
3.	Tongue movement	Slimy	Syrupy	Pasty	None	0.41 NS
	Non diabetics % (N1)	26.67 (4)	0 (0)	73.33 (11)	0 (0)	
	Diabetics % (N2)	26.67 (4)	13.33 (2)	40.00 (6)	20.00 (3)	
	Total % (N)	26.67 (8)	6.66 (2)	56.67 (17)	10 (3)	
4.	Chemical	Astringent	Burning	Sharp	None	0.91 NS
	Non diabetics % (N1)	13.33 (2)	13.33 (2)	0 (0)	73.34 (11)	
	Diabetics % (N2)	20.00 (3)	0 (0)	0 (0)	80.00 (12)	
	Total % (N)	16.67 (5)	6.66 (2)	0 (0)	76.67	(24)
5.	After feel	Clean	dry	Lingering	None	0.33 NS
	Non diabetics % (N1)	40.00 (6)	40.00 (6)	6.67 (1)	13.33 (2)	
	Diabetics % (N2)	33.33 (5)	13.33 (2)	6.67 (1)	46.67 (7)	
	Total % (N)	36.67 (11)	26.67 (8)	6.66 (2)	30 (9)	
6.	Temperature	Warm	Normal	Cold	None	0.10 NS
	Non diabetics % (N1)	6.67 (1)	96.67 (14)	0 (0)	0 (0)	
	Diabetics % (N2)	0 (0)	53.33 (8)	0 (0)	46.67 (7)	
	Total % (N)	3.33 (1)	73.34 (22)	0 (0)	23.33 (7)	
7.	Wetness	Wet	Normal	Dry	None	0.02*
	Non diabetics % (N1)	0 (0)	13.33 (2)	26.67 (4)	60.00 (9)	
	Diabetics % (N2)	0 (0)	53.33 (8)	46.67 (7)	0 (0)	
	Total % (N)	0 (0)	33.33 (10)	36.67 (11)	30 (9)	

Values are given as % (with corresponding number of frequency)
*Significant at 1% level of significance
p value is calculated between score by non-diabetics and diabetics
NS Non-significant

Dose determination

The suitability of the developed JJFP powder as a daily dose was ascertained by certain responses reported by normal and diabetic individuals and is presented in Table No. III. There was a non-significant difference between all the responses given by non-diabetics and diabetics for the dose ascertainment of JJFP. A total of 85% of individuals in both diabetic and non-diabetic groups easily consumed only one packet, i.e., 10g. A similar number of diabetic and non-diabetic individuals reported easy swallowing (93.33%), no throat irritability (100%), and a clean bowl (93.33%) after one day of taking the developed JJFP powder. To easily take the developed JJFP powder, water is recommended by both the

non-diabetic (33.33%) and diabetic groups (20%). All the respondents, both diabetics and non-diabetics, reported no change in behavior or body response after consuming the JJFP powder. Thus, it can be ascertained that the JJFP powder is safe to intake, and its acceptable dose for long-term supplementation is 10 g/day on the basis of the sensory evaluation tool. All the respondents also agreed to take 10 grams of dose for a period of three months of supplementation.

Table No. 3: Dose determination of JJFP powder

Parameters	Response	Non-Diabetics % (N1)	Diabetics % (N2)	Total	*p* value
Easy to swallow	Yes	93.33 (14)	93.33 (14)	93.33 (28)	0.46 NS
	No	6.67 (1)	6.67 (1)	6.67 (2)	
Throat irritability	Yes	0 (0)	0 (0)	0 (0)	0.86 NS
	No	100 (15)	100 (15)	100 (30)	
Clean bowl	Yes	93.33 (14)	93.33 (14)	93.33 (30)	0.46 NS
	No	6.67 (1)	6.67 (1)	6.67 (2)	
Edible Quantity	Yes	86.67 (13)	93.33 (14)	90 (27)	1 NS
of JJFP (10g)	No	13.33 (2)	6.67 (1)	10 (3)	
Need anything along	Yes	33.33 (5)	20.00 (3)	26.67 (8)	0.68 NS
with JJFP like water	No	66.67 (10)	80.00 (12)	73.33 (22)	

Values are given as % (with corresponding number of frequency)
p value is calculated between score by non-diabetics and diabetics
NS Non-significant

CONCLUSION

Thus, from the findings of the present study, it is clear that the developed JJFP powder has high organoleptic properties in terms of color, flavor, texture, aroma, taste, and overall acceptability, which mostly corresponds to liking it very much. The mouthfeel parameters of the developed JJFP powder are characterized by easy chewability, a pasty consistency in the mouth that tends to stick to teeth and the tongue, indicating slow tongue movement with normal or no change in mouth temperature, and wetness followed by a normal and dry after feel. A dose of 10 g of JJFP powder was easy to swallow without any throat irritation, and it may be taken with water if there is any problem in swallowing. The non-significant difference in sensory evaluation parameters of the developed JJFP for both diabetic and non-diabetic individuals ascertain its ease of use and high acceptability in both groups. Thus, the dose for supplementation was ascertained as 10 g/day on the basis of the developed sensory evaluation tool. Thus, the supplementation of any therapeutic food formulations for humans and dose determination by sensory evaluation tools may determine their feasibility for long-term consumption.

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