The Pharma Innovation Journal 2018; 7(12): 69-74

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.03
TPI 2018; 7(12): 69-74

www.thepharmajournal.com
Received: 19-10-2018
Accepted: 23-11-2018

Kardile NB
Department of Food Engineering, National Institute of Food Technology Entrepreneurship and Management, Kundli, Sonipat, Haryana, India

Nema PK
Department of Food Engineering, National Institute of Food Technology Entrepreneurship and Management, Kundli, Sonipat, Haryana, India

Kaur BP
Department of Food Engineering, National Institute of Food Technology Entrepreneurship and Management, Kundli, Sonipat, Haryana, India

Thakre SM
Department of Agriculture Process Engineering, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Correspondence
Nema PK
Department of Food Engineering, National Institute of Food Technology Entrepreneurship and Management, Kundli, Sonipat, Haryana, India

Fuzzy logic augmentation to sensory evaluation of *Puran*: An Indian traditional foodstuff

Kardile NB, Nema PK, Kaur BP and Thakre SM

Abstract
Puran is mixture of cooked chickpea dhal and jaggery and used as a stuffing of puran Poli- a traditional Indian sweet pan baked paratha. Puran has no standardized recipe and processing parameter. Therefore the present work was carried out to optimize recipe and processing parameter for preparation of puran by its sensory attributes. The cooked chickpea dhal and jaggery were taken in different proportion (0.5, 1 and 1.5) with three grinding times (2, 3 and 4 min). The full factorial design was used to perform the experiment. The acceptability of puran samples was checked (colour, flavour, texture and overall accessibility) by sensory analysis. The sensory score given by panel members was analysed by fuzzy logic. The results showed that Y2 sample (Chickpea dhal and jaggery, 1:1, grinding time 4 min) had the highest acceptability among the nine samples. The quality attributes of puran in general ranked in decreasing order as; flavour > overall accessibility > texture > colour.

Keywords: fuzzy logic. puran. puran poli. sensory evaluation

1. Introduction
Indian traditional cousin consists of a large variety of variation in its cousin depending upon region and tradition. Puran poli is a sweet flat bread native to Maharashtra, Andhra Pradesh, Tamilnadu and Gujarat. Puran poli has different names, "Puran Poli" or "vedmi" in Gujarat, puran poli in Maharashtra, boli in Tamil, bobbatlu/bakshalu in Andhra Pradesh, holige and obbattu in Karnataka. It is consumed mainly during the festivals like Holi, Diwali, Sankrant and Gudhi Padva. Puran poli is made up of chickpea dhal, sugar/ jaggery, wheat flour, cardamom and nutmeg (Suradkar *et al.*, 2014) [16].

Fuzzy logic mainly concentrates on issues which consist of imprecise information and not useful in situation where precision is required. Fuzzy sets theory gives a way to represents uncertainties, imprecision and vagueness. Fuzzy sets theory and fuzzy logic used in an area where intuition and judgement play an important role. Fuzzy logic may be used in complex mathematical equation where understanding on the basis of judgement and in situation where human perception, reasoning and decision are impossible to disentangle involved.

In general, fuzzy systems are consisting of fuzzy concepts like algebra, reasoning, arithmetic and topology. Fuzzy systems consist of procedures based on developing a rule, such as (1) Fuzzy variable showed a linguistic word instead of numerical values (e.g. excellent, good fair, etc.) (Zadeh, 1975) [17] (2) Fuzzy data in terms of linguistic terms of that variable (3) Fuzzy logic to elaborate relationship between the dependent and independent variable (4) Fuzzy information to calculation of responses of the fuzzy logic.

Sensory evaluation of food material gives an idea of food quality by creating an impression in the mind of the person who eats the food (Das, 2005; Giusti, *et al*., 2008) [3, 6]. The food product launched in the market without sensory analysis, has greater chances of market failure (Arazi and Kilcast, 2001) [2]. The acceptance and rejection of food is analysed by sensory evaluation (Rao and Das, 2003; Falade and Omojola, 2008; Lazim and suriani, 2009; Sinija and Mishra, 2011) [11, 4, 9, 15]. The sensory evaluation consists of sets of methods to analyse human responses to foods. Samples attributes can be compared by fuzzy sets for analysis of sensory data (Kavdir and Gayer, 2003) [7]. The fuzzy logic was successfully used to analyse the sensory data for bread prepared from composite flour (Singh *et al*., 2012) [14], dahi powder (Routray and Mishra, 2012) [12], chhana podo (Mukhopadhay *et al*., 2013) [10], jam (Shinde and Pardeshi, 2014) [13] and mango pulp and litchi juice (Kaushik *et al*., 2015) [8].

Puran is the stuffing of puran poli which contains a mixture of cooked chickpea dhal, sugar/ jaggery, cardamom and nutmeg. There is wide variation in the recipe of puran in different places. Puran is made up of chickpea dhal added with sugar or jaggery in different proportions

in different regions. Therefore, there is a need for standardization of recipe and processing parameters of puran preparation, so that consumer of puran poli will get a unique taste all over India. The objective of present study is, to optimize the recipe and processing parameter of puran by sensory analysis using fuzzy logic.

2. Materials and Methods

2.1 Raw materials

Chickpea dhal, jaggery, cardamom and nutmeg were purchased from local market of Narela, Delhi, India.

2.2 Preparation method of Puran

The cleaned chickpea dhal was soaked in portable water at 30 ºC for 135 min to absorb maximum water. After that chickpea dhal was cooked at 100^0C for 10 to 12 min. The full factorial design was used for the standardization of recipe and processing parameters of puran. Three ratios were taken for cooked chickpea dhal: Jaggery (0.5, 1.0 and 1.5) and three levels for grinding time (2, 3 and 4 min). The experimental plan is shown in Appendix 1. The mixture of cooked dhal and jaggery were cooked for 5 to 6 min to melt the jaggery. Cooking was stopped when caramel flavour starting emerging. The cooked mixture of dhal and jaggery were immediately converted in paste by mixer-grinder (Model-Philips HL7610/00). The puran paste was then passed through 500-micron sieve for uniformity. The total number of experiments were nine. The prepared samples were coded as Y1, Y2, Y3, Y4, Y5, Y6, Y7, Y8 and Y9 (Appendix 1). The prepared puran samples are shown in Figure 2.

Fig 2: Puran samples prepared with different proportion of chickpea dhal and jaggery.

2.3 Selection of panel member and sensory evaluation of puran samples

After preparation of good quality puran of different proportion of cooked dhal and jaggery. Thirty-one members (Research scholar and faculty) from Food Engineering and Food Science and Technology department of National Institute of Food Technology Entrepreneurship and Management, Kundli, Sonipat, Haryana (state: Haryana, Delhi, Maharashtra, Uttar Pradesh, Madhya Pradesh and Andhra Pradesh, age: 22-50 years, male: 16, female: 15) were selected for sensory evaluation of puran. The panel members were trained by giving information about the puran, its history, and recipe. The information provided regarding the means of quality, sensory terms used for sensory analysis, the sensory scorecard and the type of scoring. The panel members (non-smoker, and non-drinker) were selected on the basis of their food habits. The instruction was given to panel member to taste the samples between testing of two samples. The panel members were advised to mark in score sheet of respective quality attributes and quality attributes of puran in general of given samples after analyzing. The sample rating was taken as linguistic scale; "Not satisfactory /Not at all important," "Fair/Somewhat important," "Medium/ Important," "Good/Highly important," "Excellent/Extremely important," for the samples "Not at all Important," "Somewhat Important," "Important," "Highly Important," "Extremely Important" was rating for general attributes of the product.

2.4 Fuzzy estimation of sensory score

The similarity analysis was used for estimation of sensory scores (Sinija and Mishra, 2011; Routray and Mishra, 2012; Singh *et al*., 2012; Mukhopadhyay *et al*., 2013) [11, 12, 14, 10]. The five major steps used for fuzzy modelling were: 1) Overall sensory scores for puran samples were calculated in triplets. 2) A triangular membership function was used following a standard fuzzy scale.3) Overall membership for puran samples was calculated. 4) Ranking and similarity values were evaluated for puran samples. 5) Ranking in general for puran samples was determined on the basis of quality characteristics. The above steps were calculated using MATLAB (version 2009b). Table 2 represents triplets and distribution pattern on the 5-point sensory scale. The triplet consists of three numbers, the first number indicates the coordinates of the abscissa where the value of membership function is one (Figure.1B), and the second and third number denotes distance towards left and right, respectively, of the first number, where the membership function is zero (Singh *et al*., 2012) [14].

2.5 Physicochemical properties

Color value of optimised puran in terms of L* (lightness), a* (redness) and b* (yellowness) were measured by using a hand-held colorimeter (Konica Minolta, CR-400, Japan). Proximate analysis of puran sample was carried out using AOAC (2010) methods 925.10, 920.53, 920.39, 923.03 and 962.09 for moisture, protein, fat, ash and crude fiber content respectively. The total carbohydrate content was calculated by difference (Gbadegesin *et al*., 2018) [5]. Minerals (magnesium, calcium, iron) of optimised puran sample were determined using Inductively Coupled Plasma Mass Spectrometry (ICP-MS). All experiments were performed in triplicates and average reading were reported with standard deviation.

3. Results and Discussion

The sensory evaluation of puran sample was done by the 5-point scale and the sensory score given by panel member has been presented in Table 1 and 2.

Table 1: Sum of sensory scores for quality attributes of puran sample

Samples	Sensory scale factors and corresponding numerical values				
	Not satisfactory (1)	Fair (2)	Medium (3)	Good (4)	Excellent (5)
Color					
Y1	0	2	10	15	3
Y2	1	8	8	8	5
Y3	1	6	10	13	0
Y4	2	11	10	6	1
Y5	0	1	13	14	2
Y6	0	9	12	8	1
Y7	0	1	14	14	1
Y8	1	9	7	10	3
Y9	1	3	9	13	4
Flavor					
Y1	1	5	10	14	0
Y2	1	7	10	7	5
Y3	0	5	11	10	4
Y4	4	10	13	3	0
Y5	0	4	8	13	5
Y6	1	10	11	7	1
Y7	0	2	10	13	5
Y8	1	15	7	4	3
Y9	0	3	12	11	4
Texture					
Y1	0	6	13	10	1
Y2	1	6	9	9	5
Y3	0	5	8	15	2
Y4	6	9	7	5	3
Y5	0	3	10	12	5
Y6	0	9	7	13	1
Y7	0	3	9	15	3
Y8	0	7	9	12	2
Y9	0	3	14	11	2
OAA					
Y1	0	2	11	15	2
Y2	1	6	10	9	4
Y3	0	2	12	12	4
Y4	3	9	11	4	3
Y5	0	4	11	11	4
Y6	1	6	16	5	2
Y7	0	3	9	14	4
Y8	1	11	10	6	2
Y9	0	1	11	14	4

OAA- Overall acceptability

Table 2: Sum of sensory score of quality attributes of *puran* sample in general and triplets associated with sensory score

Sensory quality attributes of puran	Sensory scale factors on 5-point scale				
	Not satisfactory /Not at all important (0 0 25)	Fair/Somewhat important (25 25 25)	Medium/ Important (50 25 25)	Good/Highly important (75 25 25)	Excellent/ Extremely important (100 25 0)
Colour	0	4	15	9	2
Flavour	0	1	1	11	17
Texture	0	1	3	8	18
OAA	0	2	1	8	19

3.1 Triplets for sensory data of puran samples

The important quality parameters like, colour, flavour, texture and overall accessibility were converted into triplicates by calculating (1) sum of sensory scores (Table 1), (2) triplets associated with the sensory scale (Table 2) and (3) number of panel members.

The number of triplets for the sensory quality of puran samples were calculated. The triplets for colour of puran sample was,

$$Y1C = \frac{0(0,0,25)+2(25,25,25)+10(50,25,25)+15(75,25,25)+3(100,2,0)}{0+2+10+15+3} \quad (1)$$

Therefore, for sample 1, triplets value for colour (Y1C), flavour (Y1F), texture (Y1T) and overall accessibility (Y1O) were estimated as follows,

Y1C = (65.83, 25.00, 22.50)
Y1F = (55.83, 24.17, 25.00) (2)
Y1T = (55.00, 25.00, 24.17)
Y1O = (64.17, 25.00, 23.33)

As mentioned above like sample 1, the triples for sample 2 to sample 9 for colour, flavour, texture and overall accessibility were calculated, which is given below.

Y2C = (56.67, 24.17, 20.83)
Y2F = (56.67, 24.17, 20.83) (3)
Y2T = (59.17, 24.17, 20.83)
Y2O = (57.50, 24.17, 21.67)
Y3C = (54.17, 24.17, 25.00)
Y3F = (60.83, 25.00, 21.67)
Y3T = (61.67, 25.00, 23.33)
Y3O = (65.00, 25.00, 21.67)
Y4C = (44.17, 23.33, 24.17)
Y4F = (37.50, 21.67, 25.00)
Y4T = (41.67, 20.00, 22.50)
Y4O = (45.83, 22.50, 22.50)
Y5C = (64.17, 25.00, 23.33)
Y5F = (65.83, 25.00, 20.83)
Y5T = (65.83, 25.00, 20.83)
Y5O = (62.50, 25.00, 21.67)
Y6C = (50.83, 25.00, 24.17)
Y6F = (47.50, 24.17, 24.17)
Y6T = (55.00, 25.00, 24.17)
Y6O = (50.83, 24.17, 23.33)
Y7C = (62.50, 25.00, 24.17)
Y7F = (67.50, 25.00, 20.83)
Y7T = (65.00, 25.00, 22.50)
Y7O = (65.83, 25.00, 21.67)
Y8C = (54.17, 24.17, 22.50)
Y8F = (44.17, 24.17, 22.50)
Y8T = (57.50, 25.00, 23.33)
Y8O = (47.50, 24.17, 23.33)
Y9C = (63.33, 24.17, 21.67)
Y9F = (63.33, 25.00, 21.67)
Y9T = (60.00, 25.00, 23.33)
Y9O = (67.50, 25.00, 21.67)

3.2 Panel preference to importance of quality attributes

Preference of triplets given by individual panellist for quality characteristics of puran samples in general was estimated using (1) summation of sensory score (Table 2) (2) Triplets associated with sensory scales (Table 2) and (3) total number of panel members.

The triplets for panel member's preference for colour given as below,

$$PC = \frac{0(0,0,25)+4(25,25,25)+15(50,25,25)+9(75,25,25)+2(100,25,0)}{0+4+15+9+2} \quad (4)$$

Therefore, the triplets for panel member's preference to importance of quality attributes, colour (PC), flavour (PF), texture (PT) and overall accessibility (PO) were,

PC = (57.50, 25.00, 23.33)
PF = (86.67, 25.00, 10.83) (5)
PT = (85.83, 25.00, 10.00)
PO = (86.67, 25.00, 9.17)

3.3 Triplets for relative weightage of quality attributes of *puran* samples

The overall quality of puran samples was determined by the summation of multiplication of the triplets, which can mathematically be given by Eqns. (2) and (5). The mathematical rule was used for multiplication of triplets (g, h, i) and (j, k, l).

$$(g, h, i) \times (j, k, l) = (g \times j, g\times k + j \times h, g \times l + j \times i) \quad (6)$$

The overall sensory scores must be in between 0 to 100, for that first digit of overall sensory score reduced. Therefore, the value reduced in Eqn. (5) by a factor $1/P_{sum,}$ where P_{sum} is the sum of the first digit of the triplets. Relative weightage of quality attributes explained for colour: $PC_{rel} = PC/ P_{sum,}$ flavour: $PF_{rel} = PF/ P_{sum,}$ texture: $PT_{rel} = PT/ P_{sum}$ and for overall accessibility: $PO_{rel} = PO/ P_{sum.}$

From Eqn. (5),

$P_{sum} = 57.50 + 86.67 + 85.83 + 86.67 = 316.67$

After that, the triplets for relative weightage of quality characteristics were estimated as:

PC_{rel} = (0.181577, 0.078946, 0.073683)
PF_{rel} = (0.273681, 0.078946, 0.034210)
PT_{rel} = (0.271049, 0.078946, 0.031578) (7)
PO_{rel} = (0.273681, 0.078946, 0.028947)

The overall sensory score YO_1 for sample 1 was calculated by using triplet multiplication rule (Eqn. 6).

$YO_1 = Y1C \times PC_{rel} + Y1F \times PF_{rel} + Y1T \times PT_{rel} + Y1O \times PO_{rel}$
YO_1 = (59.70, 43.78, 34.22) (8)

A similar rule was applied for calculation of the overall sensory score for sample 2 to sample 9.

YO_2 = (57.57, 42.32, 30.71)
YO_3 = (60.99, 43.93, 32.62)
YO_4 = (42.12, 35.10, 30.67)
YO_5 = (64.62, 45.39, 32.38)
YO_6 = (51.05, 40.66, 32.52)
YO_7 = (65.46, 45.59, 32.99)
YO_8 = (50.51, 40.44, 31.65) (9)
YO_9 = (63.91, 44.91, 32.80)

3.4 Standard fuzzy scale and ranking of puran samples

The standard fuzzy scale, shown in Figure 1A, which is a distribution pattern of the triangular membership function. Membership functions characterize the fuzziness in a fuzzy set in a graphical form for eventual use in the mathematical formulation of fuzzy systems. The linguistic terms of standard fuzzy scale were a group of not satisfactory, Fair, Satisfactory, Good, Very good and Excellent respectively. The membership function of each of the sensory scales follows triangular distribution pattern where the maximum value of membership is one.

The overall quality score of puran samples was connected to the standard fuzzy scale. The overall quality, as shown by the triplet (g, h, i) was represented by a triangle GHI, shown in Figure1B. The first digit of the triplet indicates the quality rating of the puran samples. Ranking of a puran samples can be done by finding the location of the centroid of the triangle GHI, as depicted by the triplet (g, h, i) of puran sample. It may be concluded that GHJ and HJI are right angle triangles and the centroid of these triangles will be at a distance 1/3 from their base. Therefore, the area of triangles GHI, GHJ and HJI were 0.5(h + i), 0.5h and 0.5i respectively. On the basis of area, we get value of distance X (Figure 1B) of the centroid of triangle GHI as,

$$X = g - (h - i)/3 \quad (10)$$

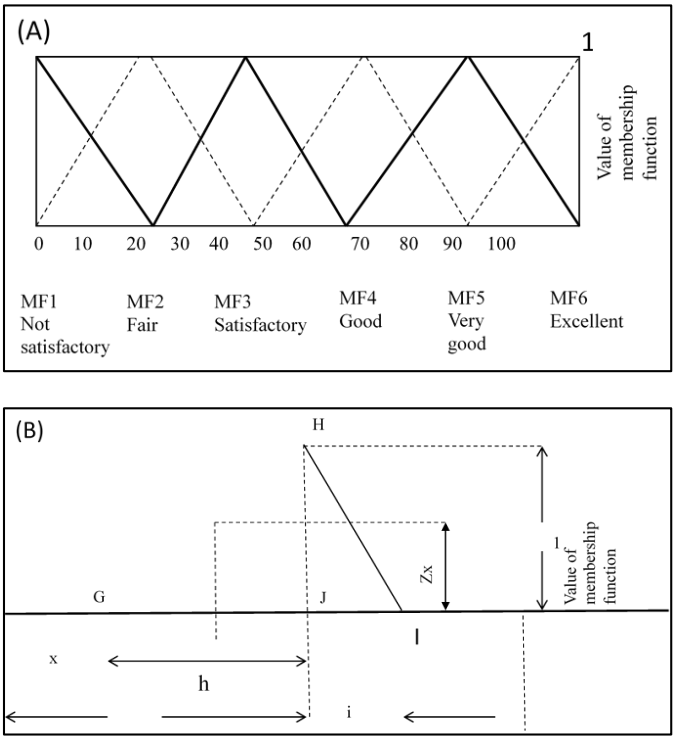

Fig 1: Graphical representation of. (A) Standard fuzzy scale used for ranking of puran samples. (B) Triplet (g, h, i) and its membership function.

3.5 Quality attributes ranking of *puran* in general

The quality attributes ranking of puran in general done in the same manner of that of ranking of puran samples. The triplet values for panel member's preference to the importance of quality putting in Eqn. (10). The output of relative preferences of the quality parameters X_{PC}, X_{PF}, X_{PT} and X_{PO} of puran as,

$X_{PC} = 56.94$
$X_{PF} = 81.94$ (11)
$X_{PT} = 80.83$
$X_{PO} = 81.39$

On the basis of relative preferences of the quality attributes X_{PC}, X_{PF}, X_{PT} and X_{PO} of the puran samples, the quality attributes puran samples were ranked as,
Flavour > Overall accessibility > Texture > Colour

3.6 Similarity analysis for *puran* samples on standard fuzzy scale

The similarity analysis useful and used for spreading the overall sensory score among the six standard fuzzy scale. By using similarity analysis, the sensory score converted into linguistic terms and puran samples were ranked.

The value of membership function of MF1 to MF6 was elaborated by a group of ten numbers, given by Shinde and Pardeshi (2014) [13].

The membership values of membership functions (Figure 1A) MF1, MF2, MF3, MF4, MF5 and MF6 were,

MF1 = (1, 0.5, 0, 0, 0, 0, 0, 0, 0, 0)
MF2 = (0.5, 1, 1, 0.5, 0, 0, 0, 0, 0, 0)
MF3 = (0, 0, 0.5, 1, 1, 0.5, 0, 0, 0, 0)
MF4 = (0, 0, 0, 0, 0.5, 1, 1, 0.5, 0, 0) (12)
MF5 = (0, 0, 0, 0, 0, 0, 0.5, 1, 1, 0.5)
MF6 = (0, 0, 0, 0, 0, 0, 0, 0, 0.5, 1)

3.7 Membership function of overall sensory score

The membership function value of overall sensory scores for puran samples on the standard fuzzy scale was estimated. The membership values were represented as triplets in Eqn. (10). Figure 1B described the graphical picture of overall sensory scores as triplets (g, h, i). The figure showed membership function value is 1 when the value of abscissa is g and is zero when the abscissa less than (g – h) or greater than (g + i). for a given value of x on, value of membership function abscissa D_x can be determined as (Singh *et al*, 2012) [14].

$D_x = \frac{x-(g-h)}{g}$ for (g – h) < x < g
$D_x = \frac{(g+i)-x}{c}$ for g < x < (g + i) (13)
$D_x = 0$ for all values of x

Therefore, the value of D_x for puran samples triplets at x = 0, 10, 20, 30, 40, 50, 60, 70, 80, 90 and 100 were estimated by Eqn. (13). The membership function of every puran sample for an overall sensory score on the standard fuzzy scale was estimated by a group of 10 numbers. These membership function values were the maximum values of D_x in the 10 intervals from 0 to 100 in the given range of x. the results are represented in Eqn. (14).

D1 = (0.00, 0.09, 0.32, 0.55, 0.78, 1.00, 0.99, 0.70, 0.41, 0.11)
D2 = (0.00, 0.11, 0.35, 0.58, 0.82, 1.00, 0.92, 0.60, 0.27, 0.00)
D3 = (0.00, 0.07, 0.29, 0.52, 0.75, 0.98, 1.00, 0.72, 0.42, 0.11)
D4 = (0.08, 0.37, 0.65, 0.94, 1.00, 0.74, 0.42, 0.09, 0.00, 0.00)
D5 = (0.00, 0.02, 0.24, 0.46, 0.68, 0.90, 1.00, 0.83, 0.53, 0.22) (14)
D6 = (0.00, 0.24, 0.48, 0.73, 0.97, 1.00, 0.72, 0.42, 0.11, 0.00)
D7 = (0.00, 0.00, 0.22, 0.44, 0.66, 0.88, 1.00, 0.86, 0.56, 0.26)
D8 = (0.00, 0.25, 0.49, 0.74, 0.99, 1.00, 0.70, 0.38, 0.07, 0.00)
D9 = (0.00, 0.03, 0.25, 0.48, 0.70, 0.92, 1.00, 0.80, 0.50, 0.19)

3.8 Similarity values for puran samples

The membership function of nine puran samples (D1 to D9) were compared with their respective values of the membership function of standard fuzzy scale from Eqn. (12). After that similarity values for puran samples under MF1 (Not satisfactory), MF2 (Fair), MF3 (Satisfactory), MF4 (Good), MF5 (Very good) and MF6 (Excellent) were estimated using Eqn. (15). The results of similarity values for puran samples given in Table 3.

$$S_m = \frac{MF \times D^T}{\text{Maximum of } (MF \times MF^T \text{ and } D \times D^T)} \quad (15)$$

Table 3: Similarity values for puran samples

Scale factors	Similarity values for puran samples								
	Y1	**Y2**	**Y3**	**Y4**	**Y5**	**Y6**	**Y7**	**Y8**	**Y9**
Not satisfactory, MF1	0.01	0.02	0.01	0.08	0.00	0.03	0.00	0.04	0.00
Fair, MF2	0.19	0.22	0.17	0.48	0.14	0.32	0.12	0.32	0.15
Satisfactory, MF3	0.54	0.61	0.53	0.83	0.48	0.71	0.46	0.72	0.50
Good, MF4	0.74	0.77	0.76	0.54	0.73	0.70	0.70	0.69	0.75
Very Good, MF5	0.45	0.39	0.47	0.09	0.55	0.26	0.57	0.23	0.54

Puran samples quality was analysed by the maximum similarity value among the nine samples. The estimated maximum similarity values for nine samples were 0.74 (Good) for Y1, 0.77 (Good) for Y2, 0.76 (Good) for Y3, 0.83 (Satisfactory) for Y4, 0.73 (Good) for Y5, 0.71 (Satisfactory) for Y6, 0.70 (Good) for Y7, 0.72 (Satisfactory) for Y8 and, 0.75 (Good) for Y9. On the basis of these maximum similarity values, the order of ranking of puran samples was: Y2 (Good) > Y3 (Good) > Y9 (Good) > Y1 (Good) > Y5 (Good) > Y7 (Good) > Y4 (Satisfactory) > Y8 (Satisfactory) > Y6 (Satisfactory). The Y2 sample had maximum similarity values, which contains chickpea dhal and jaggery in 1:1 proportion and grinding time 4 min. The texture of Y2 sample was smooth due to more grinding and acceptable colour due to equal proportion of dhal and jaggery.

3.9 Physicochemical properties

Physicochemical properties of optimised puran sample were determined. The color value of puran in terms of L, a and b were 58.88 ± 0.40, 5.96 ± 0.11 and 34.97 ± 0.28 respectively. The moisture, protein, fat, carbohydrate, crude fiber and ash content of puran sample were 58.88%, 17.52%, 4.1%, 22.9% and 2.29% respectively. Magnesium, calcium and iron content of puran sample were 389.7, 297.9 and 15.66 µg/g respectively.

4. Conclusion

Puran samples prepared using different proportions of chickpea dhal and jaggery with different grinding time. The sensory analysis of puran samples was done by five-point hedonic scale. The fuzzy logic was used for analysis of sensory data. The results showed that puran sample Y2 (Chickpea dhal and jaggery (1:1), grinding time 4 min) was more acceptable. The quality attributes of puran in general ranked in decreasing order as; flavour > overall accessibility > texture > colour.

5. Acknowledgments

The author would like to thank Miss Rachana Sehravat, Mr. Ayon Tarafdar, Mr. Siba Prasad Naik and Mr. Vaibhav Kale, department of Food Engineering, NIFTEM, Kundli, Haryana for their valuable contribution

6. References

1. AOAC. Officials methods of analysis AOAC International, 18th ed. Gaithersburg, MD, AOAC International, 2010.
2. Arazi S, Kilcast D. Leatherhead of food R.A. Food Processing Journal, 2001, 21-22.
3. Das H. Food processing operation analysis (1st ed.). New Delhi, India: Asian Books Private Limited, 2005.
4. Falade KO, Osmojola BS. Effect of processing methods on physical, chemical, rheological and sensory properties of okra (Abelmoschus esculentus). Food and Bioprocess Technology. 2008; 3(3):387-394.
5. Gbadegesin AR, Odunlade TV, Otunola ET. Nutritive and sensory properties of okra fortified instant fufu. International Food Research. 2018; 25(3):1031-1035.
6. Giusti AM, Bignetti E, Cannella C. Exploring new frontiers in total food quality definition and assessment: From chemical to neurochemical properties. Food and Bioprocess Technology. 2008; 1:130-142.
7. Kavdir U, Guyer DE. Apple grading using fuzzy logic. Turkish Journal of Agriculture. 2003; 27:375-382.
8. Kaushik N, Gondi AR, Rana R, Rao SP. Application of fuzzy logic technique for sensory evaluation of high pressure processed mango pulp and litchi juice and its comparison to thermal treatment. Innovative Food Science and Emerging Technologies. 2015; 32:70-78.
9. Lazim MA. Suriani M. Sensory evaluation of selected coffee products using fuzzy approach. World Academy of Science, Engineering and Technology. 2009; 50:717-720.
10. Mukhopadhyay S, Majumdar GC, Goswami TK, Mishra HN. Fuzzy logic (similarity analysis) approach for sensory evaluation of *chhana podo*. LWT- Food Science and Technology. 2013; 53:204-210.
11. Rao PK, Das H. Fuzzy logic-based optimization of ingredients for production of mango bar and its properties. Journal of Food Science and Technology. 2003; 40(6):576-581.
12. Routray W, Mishra HN. Sensory evaluation of different drinks formulated from dahi (Indian yogurt) powder using fuzzy logic. Journal of Food Processing and Preservation. 2012; 36(1):1-10.
13. Shinde KJ, Pardeshi IL. Fuzzy logic model for sensory evaluation of commercially available jam samples. Journal of Ready to Eat Food. 2014; 1(2):78-84.
14. Singh KP, Mishra A, Mishra HN. Fuzzy analysis of sensory attributes of bread prepared from millet-based composite flours. LWT- Food Science and Technology. 2012; 48:276-282.
15. Sinjia VR, Mishra HN. Fuzzy analysis of sensory data for quality evaluation and ranking of instant green tea powder and granules. Food Bioprocess Technology. 2011; 4(3):408-416.
16. Suradkar NG, Kamble D, Fulpagar V. Nutritional characterization of Indian traditional Puran Poli. International Journal of Engineering Research and General Science. 2014; 2(6):583–589.
17. Zadeh LH. The concept of linguistic variable and its applications to approximate reasoning- II. Information science. 1975; 8:301-357.