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Standardization, formulation and evaluation of Tur dal analogues developed from redgram brokens

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Abstract
The present study was carried out with an aim of the standardization, formulation and evaluation of Tur dal analogue developed from redgram brokens. Three formulations were selected based on previous literature. Tur dal analogues were developed with the three different formulations in twin screw extruder such as 1). Red gram brokens flour, 100%; GMS, 1.0%; $CaCl_2$, 0.2% and Turmeric powder, 0.1%. 2). Red gram brokens flour, 100%; GMS, 1.0%; $CaCl_2$, 0.2% and Turmeric powder, 0.2%. 3). Red gram brokens flour, 100%; GMS, 1.0%; $CaCl_2$, 0.2%; Turmeric powder, 0.2% and Guar gum, 0.1%. Each combination was pre-conditioned to 20% moisture and extruded into dal analogues by maintaining barrel temperature at 150 °C with a screw speed of 150 rpm and feed rate of 50 kg/hr. The resultant Tur dal analogues were evaluated by sensory evaluation after cooking. The panelists accepted and rated high for the dal analogue prepared from formulation 2, containing Red gram brokens flour, 100%; GMS, 1.0%; $CaCl_2$, 0.2% and Turmeric powder, 0.2%.

Keywords: Redgram brokens, milling losses, extrusion, Tur dal analogues, pulse analogues

Introduction
Dal is the key constituent of balanced diet and rich source of dietary protein for large portions of the world's population, particularly in nations where people's consumption of animal protein is restricted by a lack of availability or is self-imposed due to religious or cultural habits, especially for India's vegetarian population (Praveen *et al*., 2019) [6]. In addition, the high-protein legumes are referred to as "poor man's meat" (Iriti and Varoni, 2017) [2]. Global production of pulses decreased from five million hectares in 1968 to 3.9 million hectares in 2007. By 2050, the world's expanding population will necessitate a 70% rise in agricultural output (FAO, IYP-2016). There are more than 171 nations in the globe where pulse crops are produced. Asia and the Indian Subcontinent in particular, is where pulses are primarily grown. Pulses are grown in India under a variety of agro-climatic conditions. India is the greatest producer, importer, and consumer of pulses. The top five producers of pulses worldwide are India (23.1%), China (12.08%), Myanmar (7.57%), Canada (6.7%), and Brazil (4.03%), which together account for 50% of global production (Guntukula, 2018) [1]. Over the past 40 years, the output of pulses has grown by less than 1% annually, which is less than half the pace of increase in the Indian population.

An important primary pulse crop grown in India is red gram also known as tur dal (*Cajanas cajan*). This crop produces 3.32 million tonnes yearly, or about 15.1% of all the pulses produced in India. Red gram dhal is a crucial component of Indians' daily vegetarian meals, so dehusking and breaking the grain into dhal is a necessary step. The husk's degree of loosening from the cotyledons and the reduction of the influence of mucilaginous linkages may have contributed to the changes in milling fractions achieved with the pre-treatment. When choosing a pre-treatment before milling red gram into dhal, cooking time and dhal flavour are also crucial considerations. Red gram is typically eaten as dry split dhal or is used to make flour. Typically, split and whole pulses are cooked and served as a side dish with rice or authentic Indian naan (roti). Red gram dal contains 21.7 g of protein, 1.5 g of fat, 55.23 g of carbohydrate, 9.06 g of dietary fibre, 321.7 kcal of energy, 108 g of total folates, 2.63 mg of zinc, and 71.7 mg of calcium per 100 g. (Longvah *et al*., 2017) [4].

The small brokens and fine powders discovered during scoring and concurrent dehusking and splitting operations can be blamed for the milling losses in commercial pulses mills. At various milling phases, a significant percentage of loss occurs. Depending on the type and quality of the grain milled, the methods and equipment used for milling, and other considerations, this

may vary by 10 to 15 percent. The fracture of dhal kernels during the milling process is a problem in the dhal milling industry, and customers don't generally like these broken kernels.

These broken kernels can be extruded to form reconstituted dhal kernels by mixing them with the required additives to enhance their quality. Here, bringing the red gram brokens and powders into shape and colour of Natural Tur dal using extrusion technology is a challenging task. Additives will play the major role to keep extruded product intact and shape after cooking. The present work was carried out to finalize the best formulation for development of Tur dal analogues in twin screw extruder using sensory evaluation.

Materials and Methods

The methodological details of experiment conducted during the course of investigation have been portrayed under the following sub headings.

Raw Materials

Brokens and fines of Redgram dal *(Cajanus cajan)* variety of PRG- 176 were procured from different dal industries in Telangana and Andhra Pradesh as shown in plate no. 1.

Plate 1: Brokens and fines of Redgram dal

Chemicals

Calcium chloride - It is used as a firming agent during food processing operations.

Glycerol monostearate (GMS) - It is used as emulsifying agent.

Guar gum powder - It is used as binding agent to get intact structured product.

Turmeric powder – It is used as natural colouring agent.

Equipments

The processing equipments like pulverizer, blender, twin screw extruder and continous dryer were used at M/s Best Engineering Technologies Pvt Ltd, IDA Bollaram, Hyderabad.

Procedure for development of Tur dal analogues

Tur dal (Redgram) brokens and fines were grounded into fine flour using pulverizer. The particle size of the flour was maintained to 100% pass through BSS 18 No. mesh screen. The flow chart for the preparation of Tur Dal Analogues has been presented in the Figure 1.

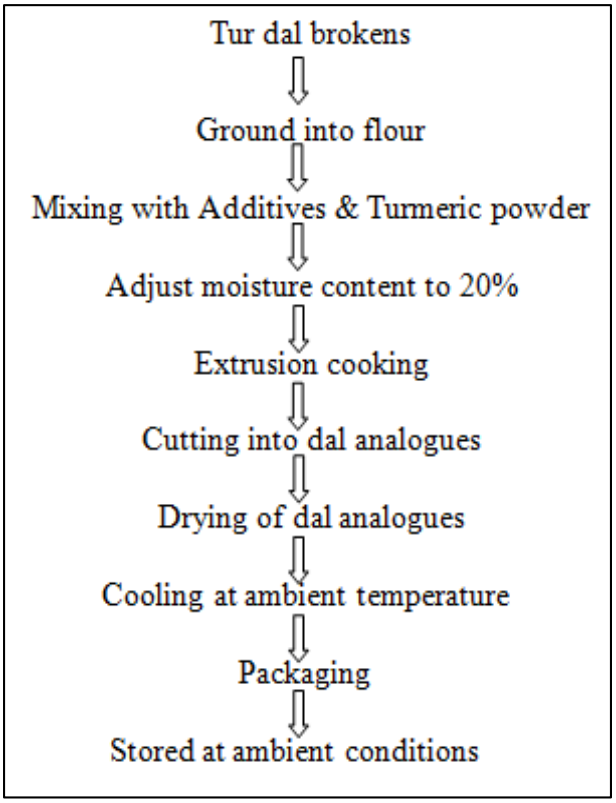

Fig 1: Flow chart for preparation of Tur Dal Analogues

A mixture of red gramme flour, calcium chloride, glycerine monosterate, and turmeric powder added in various ratios in accordance with the three formulations listed in Table 1.

Table 1: Ingredients formulations for development of Tur dal analogues

S. No	Ingredients	Formulation-1 Levels	Formulation – 2 Levels	Formulation-3 Levels
1	Red gram brokens flour	100%	100%	100%
2	GMS	1.0%	1.0%	1.0%
3	Calcium chloride	0.2%	0.2%	0.2%
4	Turmeric powder	0.1%	0.2%	0.2%
5.	Guar Gum	-	-	0.1%

The blended samples were conditioned to 20% (w.b) moisture by spraying calculated amount of water and mixing continuously at medium speed in a blender. The samples were packed in HDPE bags/trays and stored at 4 °C temperature over night.

The feed material was then allowed to stay for 3hr to equilibrate at room temperature prior to extrusion.

Extrusion was performed using a pilot scale co-rotating twin-screw extruder at barrel temperature 150 °C with 150 rpm screw speed and 50kg/h feed rate. The circular die opening of 6 mm size with 20 holes was used to obtain 6 mm size extrudates. The extrudates were subsequently dried at 65˚C with a 5 pass continuous air dryer adjusted for 1hr 15 min retention time to attain safest moisture level (5-6%). These Tur dal analogues were stored in LDPE pouches for further cooking and sensory evaluation. The developed Tur dal analogues were shown in Plate No.2

Plate 2: Developed Tur Dal Analogues with formulation 2

Sensory Evaluation

The cooked Tur dal analogues were organoleptically evaluated by semi trained twenty panels of judges. The tur dal analogues were evaluated for various sensory quality characteristics such as color, flavor, taste, texture, appearance, and overall acceptability. Evaluation of the product was done on the basis of 9 point hedonic scale.

Results and Discussion

The present study was based on the standardization, formulation and evaluation of Tur dal analogues developed from redgram brokens flour with additives using Twin screw extruder. Tur dal analogues developed with three formulations were cooked (Plate No. 3) and added with small quantity of salt. These cooked dal analogue were evaluated organoleptically with semi trained panelists. The resulted are presented in Table 1.

Table 1: Sensory evaluation of Tur dal analogues

Samples	Appearance	Colour	Flavour	Texture	Taste	Overall acceptability
Control	8.0	8.1	8.2	8.8	8.6	8.7
R1	7.3	7.2	7.7	7.4	7.4	7.5
R2	7.4	7.6	7.8	7.7	7.5	7.8
R3	7.3	7.4	7.7	7.2	7.5	7.1

Control – Natural tur dal
R1 –Tur dal analogues developed with formulation - 1
R2- Tur dal analogues developed with formulation - 2
R3- Tur dal analogues developed with formulation – 3

The mean sensory scores of control sample was found to be ranked as the highest in all sensory parameters *viz*., 8.0 for appearance, 8.1 for color, 8.2 for flavor, 8.8 for texture, 8.6 for taste and 8.7 for overall acceptability. The next highest sensory score was obtained for Tur dal analogues (R2) developed from formulation –2 in all sensory attributes *viz*., 7.4 for appearance, 7.6 for color, 7.8 for flavor, 7.7 for texture, 7.5 for taste and 7.8 for overall acceptability.

Plate 3: Cooked Tur dal analogues

Further the sensory panelists reported the stickiness in the cooked tur dal prepared from the formulation containing Guargum, i.e. formulation -3. The panelists reported pale yellowish color of extruded tur dal in case of the tur dal analogue produced from formulation containing less turmeric powder, i.e. formulation –1. The panelists accepted the tur dal and rated high for the dal analogue prepared from formulation-2 containing Red gram brokens flour, 100%; GMS, 1.0%; $CaCl_2$, 0.2% and Turmeric powder, 0.2%. The overall acceptability reported as 8.7, 7.5, 7.8 and 7.1 for control sample, R1, R2 and R3 sample respectively shown in Fig. 2.

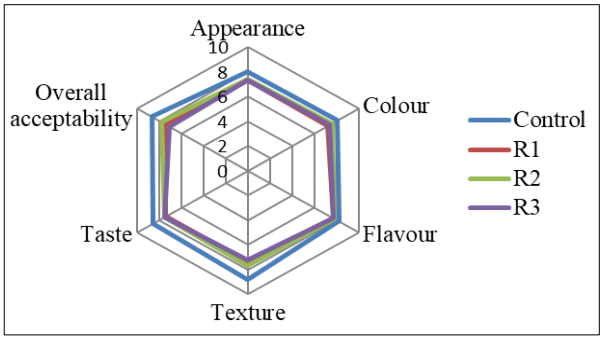

Fig 2: Sensory evaluation of developed Tur dal analogues

Conclusions

This kind of study facilitates the development of dal analogues from brokens and powders of pulses to reduce the shortfall between demand and supply of dals in the market. This research study reveals that the Tur dal analogues developed from formulation does not have guar gum powder and more percentage of turmeric powder had more sensory acceptability.

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