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Optimization of Malting Process of Horse Gram and its Effect on Biochemical, Anti-nutritional Factors and Utilization in Nutri-drink Mix

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ABSTRACT: The present study was carried out in order to study the optimization process for malting of horse gram and its effect on various factors such as proximate, anti-nutritional compounds. Initially, process optimization with varying steeping and germination time period was done to determine the malt yield and malt losses. The malt yield was found higher in fourth optimized condition *i.e.*, 80.35% with reduced loss 6.47%. The nutritional profile showed the enhanced levels of proteins and ash content *i.e.*, 24.2% and 3.4% as compared to the raw horse gram flour. The anti-nutritional factors such as phytic acid and tannins of malted flour was found to reduce significantly as 4.736 ± 0.421 mg/g, 5.7 ± 0.31 mg/g as compared to the raw flour 10.60 ± 0.65 mg/g, 18.22 ± 1.30 mg/g respectively.
The nutri-drink mix was formulated by incorporation of levels of horse gram malt flour as 5%, 10%, 15 % and 20%. The organoleptic was done for the nutri-drink mix where the trial T3 *i.e.*, with 15 % incorporation of horse gram malt flour found to have higher score *i.e.*, 8.3 for overall acceptability. The utilization of malt flour in nutri-drink mix was performed and the mix was organoleptically acceptable.

Keywords: anti-nutritional, organoleptic, optimization, malting, mix.

INTRODUCTION

Food legumes, a prime edible source of major and minor nutrients, functional compounds are contemplated now to have right time to envision the depiction of processing, its utilization and consumption with genuine perspective in human diets. Horse gram, an obscured and under explored food leguminous crop is found to be abundant in major nutrients and bioactive compounds.

Horsegram *Macrotyloma uniflorum* (Lam.) *Verdc*., belonging to family Fabaceae, a leguminous major crop of ancient India, native to Southeast Asia and tropical Africa (Chahota *et al*., 2013), grown in arid and semi-arid regions, Horsegram seeds found generally to be hardy in raw form and gets soften on treatments as soaking, boiling, soaking, steaming operations. Horsegram, a poor man's meat, is known by various terms in different languages as Kulith (marathi), kollu (southern part of India), and Madras bean or madras gram. The term Horsegram remarks it significance to be great-powered source used to fed race horses (Gaikwad and Ghatge 2022). The Sanskrit term refers horsegram as Tamrabeej, which is due to its coppery color on coat surface. The utilization of this powered grain in developing food products, extraction of proteins, amino-acids or other bioactive compounds will contribute to enhance the nutritional characterization, ensuring food security and have caused consumers to eschew conventional meat-based proteins in favour of natural plant-derived proteins (Banerjee *et al*., 2022).

Application of various pre-treatments and processes like cooking, soaking (steeping), steaming, germination enhance the textural and functional acceptance of the horsegram. The primary purpose of malting is to encourage the production of hydrolytic enzymes, lacking from ungerminated grain (Dewar, 2003; Latha and Muralikrishna 2009). Malting was also described by Gupta *et al*. (2010) as the controlled germination of cereals to achieve a desired physical, functional and biochemical alteration in the grain, which is subsequently stabilised by grain drying. Malting, a three-step process of steeping, germination and drying of grains, helps induce the nutrients and functional properties. Moreover, malting of grains assists in reduction of levels of anti-nutritional factors like phytates and tannins by 39.66 % and 24.77 percent respectively and boost the availability of iron and zinc (Baranwal, 2018). Furthermore, the utilization of malted legume crops will ensure the commercial ease in availability, and serve as inexpensive source of nutrients enhancing bio-availability and nutritional security.

The post-pandemic situation has accelerated a huge demand for health-based foods and beverages; especially developed of locally available raw material as millets, legumes, natural sweeteners, etc. On other hand, the trends of consumption of convenience foods, ready-to-eat, ready-to-cook, instant mixes play a major role in ease of food preparations. Malted beverages are made from malt by combining it with other cereal and legume flour, whole milk, milk powder, and/or cocoa powder. Malt-based health drinks (MBHD) are nourishing beverages that increase milk consumption by enhancing the flavour of the beverage (Mohanty *et al.,* 2022). The Indian market generally commercializes the malt-based drinks as the healthy or nutritious drinks, which serves as a major target population for kids and children. The innovation of malted drinks extends to the women and adult category for increase in bone density as developing the micro-nutrient rich (calcium-rich) products. The main objective of the following research work was to study the malting process optimization its effect on horse gram and utilize the malt flour in the health product *i.e.,* nutri-drink mix.

MATERIAL AND METHODOLOGY

A. Selection of ingredients

The legume crop Horse gram was selected as the major ingredient for the study. Other ingredients for development of nutri-drink mix selected were finger millet, watermelon seeds, flax seeds, jaggery, cocoa powder, skim milk powder and guar-gum as stabilizer. The selected raw material was procured from the local market of Parbhani. The visual inspection of the raw material was carried out and grains/seeds were cleaned for any extraneous matter.

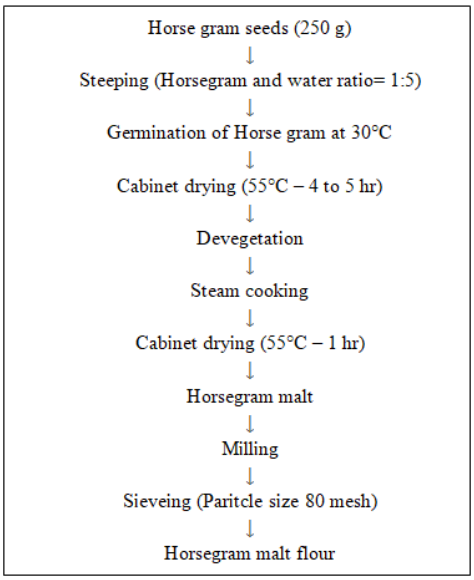
B. Malting process

Initially, the malting process optimization by varying time conditions for steeping and malting of horse gram was the major focus of the study. The horsegram were steeped initially in lukewarm water at the ratio of 1:5. The malting of horse gram was performed by optimization of steeping time, germination time and maintained germination temperature of 30°C. The germinated horsegram was further subjected to cabinet drying (55° C), devegetated to remove the rootlets. Further, the germinated horsegram sprouts were grinded to flour and sieved to obtain fine malt flour powder.

Table 1: Process optimization for malting of horse gram.

Process optimization	Steeping (hr)	Germination (hr)
Treatment 1	4	15
		24
		30
Treatment 2	8	15
		24
		30
Treatment 3	12	15
		24
		30

Preparation of horse gram malt flour:



Flowchart 1. Malting of Horsegram.

Fig. 1. Horsegram (raw, malted and malted flour).

C. Proximal analysis

The bio-chemical parameters of malted horsegram flour in comparison to raw horsegram flour was determined. The moisture content, ash contents were determined by the standard method (AOAC, 1990). The determination of protein content was estimated by the Kjeldahl method by initially calculating nitrogen content and further protein from the nitrogen content. The crude fat was extracted and measured by the Soxhlet apparatus using n-hexane, as per AACC, (2000). The crude fibers and total carbohydrates were performed according to the methodology described by Ranganna (2011).

D. Anti-nutritional factors

The anti-nutrtional factors were estimated for anti-nutrients such as phytates and tannins.

E. Preparation of nutri-drink mix

For preparation of nutri-drink mix, the raw ingredients such as finger millet, watermelon seeds and flax seeds were processed as initially roasting followed by grinding and sieving to obtain fine powdered flour. Other ingredients such as sweetener- Jaggery, flavoring- cocoa powder, emulsifier- Skim milk powder, and stabilizer- guar gum. For preparation of 100 g of nutri-drink mix, the horsegram malt flour was incorporated at the levels of 5%, 10%, 15%, and 20%. The control sample with 0% malt and 30% finger millet flour, which was replaced by malt flour in the following trial series.

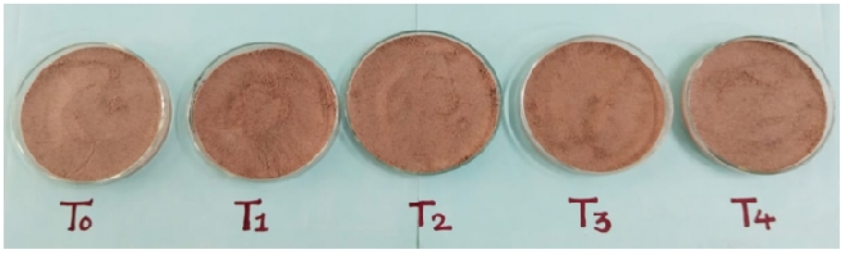
Table 2: Formulation of nutri-mix incorporated with horsegram malt.

Ingredients	Finger millet flour	Horsegram malt flour	Jaggery	Cocoa powder	SMP	Water-melon seed	Flax seed	Guar gum
Control	35	**0**	40	10	10	2.5	2.0	0.5
T1	30	**05**	40	10	10	2.5	2.0	0.5
T2	25	**10**	40	10	10	2.5	2.0	0.5
T3	20	**15**	40	10	10	2.5	2.0	0.5
T4	15	**20**	40	10	10	2.5	2.0	0.5

The nutri-drink mix 20 g was added to 250 ml of hot milk and stirred well to reconstitute.

F. Sensory evaluation

The organoleptic evaluation of nutri-drink mix incorporated with horsegram malt flour was performed by 9-point hedonic rating scale, by the semi-trained panel members.



T_0 is nutri-drink mix without horsegram malt flour
T_1 is nutri-drink mix with 5 percent horsegram malt flour
T_2 is nutri-drink mix with 10 percent horsegram malt flour
T_3 is nutri-drink mix with 15 percent horsegram malt flour
T_4 is nutri-drink mix with 20 percent horsegram malt flour

Fig. 2. Trial formulations of nutri-drink mix.

G. Statistical analysis

The results obtained were in triplicate (n = 3) and expressed as mean ± standard deviation and for sensorial analysis, the standard error and critical difference at 5% was determined.

RESULTS AND DISCUSSION

A. Optimization for malting process

The data for process optimization of horsegram with respect to the length of ascospires, malting losses (%) and malt yield (%) was calculated and presented in table 3. The simultaneous increase in steeping time and germination time depicts the increase in the malt yield, while decrease in the malt losses.

The length of ascospires increased with increase in soaking and germination time (hr); the length of ascospires increased from 0.95 cm to 1.23 cm. Similarly, the malting losses decreased from 8.45 per cent to 6.47 per cent, while simultaneous increase in malt yield from 58.26 per cent to 82.35 per cent was observed. The length of ascospires (cm) was found to be best in soaking time 12 hr and germination time 24 hr, i.e., 1.23 cm. Similarly, highest malt percent (82.35 per cent) was obtained in soaking time 12 hr and germination time 24 hr treatment. Anandkumara, 2016 recorded similar results in accordance to increase in malt yield by optimizing the soaking and germinating time.

Table 3: Malting process optimization of horsegram.

Parameters	Length of ascospires* (cm)	Malting losses (%)	Malt yield (%)
Optimization 1	0.95	8.45	58.26
Optimization 2	1.09	7.98	60.88
Optimization 3	1.15	7.08	68.31
Optimization 4	1.23	6.47	82.35

B. Proximal analysis of raw and malted horsegram flour

Table 4 depicts the proximal composition of horsegram flour (raw and malted). The malted horsegram flour showed the moisture content as 7.5 ± 0.07 g/100 g which is significantly higher than that of raw horsegram flour 6.88 ± 0.07 g/100 g. The increase in moisture content may be due to more addition of water during stages of soaking and germination in process of malting. The protein content of raw and malted horsegram flour was observed 22.05 ± 0.11 percent and 24.2 ± 0.53 per cent respectively. The decrease in protein levels of malted horsegram flour might be due to denaturing of proteins during germination. The lowered level of proteins may be due to utilization of amino acids and peptides during growth and increase in proteolytic activity. Similar results for decreased protein levels due to enhanced protease activity on increase in time of germination was recorded by Handa *et al.* (2017). The slight reduction in levels of carbohydrates and fat was observed as 64.66 ± 1.42, 63.9 ± 0.22 percent and 1.34 ± 0.11, 0.9 ± 0.36 percent respectively. This may be due to germination effect of horsegram seeds; due to increase in alpha-amylase and lipase activity. The similar pattern trends were found for germinated mung bean, reported by Megat Rusydi *et al*. (2011).

Table 4: Nutritional composition of nutri-drink mix.

Parameters (%)	Raw Horsegram flour	Malted Horsegram flour
Moisture	6.88 ± 0.07	7.5 ± 0.07
Protein	24.2 ± 0.53	22.05 ± 0.11
Fat	1.34 ± 0.11	0.9 ± 0.36
Ash	2.27 ± 0.08	3.4 ± 0.10
Carbohydrate	64.66 ± 1.42	63.9 ± 0.22
Crude fibers	4.92 ± 0.84	2.5 ± 0.06

C. Anti-nutritional factors

The tabulated data below represents that the phytic acid content in raw horsegram flour and malted horsegram flour is 10.60 ± 0.65 mg/g and 4.736 ± 0.421 mg/g respectively. Similarly, the tannins in raw horsegram flour and malted horsegram flour was determined to be 18.21 ± 1.301 mg/g and 8.7 ± 0.31 mg/g respectively. The phytic acid and tannins were found to be decreased after the process of malting. Thus, malting helps in reduction of anti-nutritional factors present in horsegram. Similar reduction in levels of phytates and tannins after malting of horse gram was noted by Pagar *et al*. (2021). The reduction during germination was due to consumption of phytates in growth. The tannins are water-soluble mainly present in seed coat of horsegram, hence get lost in water during steeping and dehulling after germination and drying.

Table 5: Anti-nutritional factors in Raw Horsegram flour and Malted Horsegram flour.

Parameters	Raw Horsegram flour (mg/g)	Malted Horsegram Flour (mg/g)
Phytic acid	10.60 ± 0.66	4.7 ± 0.42
Tannins	18.22 ± 1.30	5.7 ± 0.31

D. Sensory analysis of nutri-mix

The data from table 6 represents mean value of sensorial parameters of the prepared nutri- mix, with incorporating varying levels of malted horsegram flour. Data from table 6revealed that sample T_3 obtained higher score for color and appearance *i.e*., 8.1 whereas lowest color value was observed in T_4 *i.e.*, 7.4. Sample T_3 obtained highest score for flavor *i.e*. (8.0) while sample T_4 obtained less score for flavor i.e. (6.9). The sample T_3 obtained maximum score for taste (8.0) whereas sample T_4 obtained similar score for taste (7.1). When drink mix is fortified with more than 15 per cent by malted drink mix then taste and textural attributes of mix get affected.

The sample T_3 obtained good score for overall acceptability (8.2) as compared to control and other sample. Thus, on overall acceptability score T_3 (15 percent malted horsegram flour) was considered as standardized and used for further substitution. The nutri-drink mix sample T_3 was found significantly superior over other mix samples with respect to all sensory quality attributes.

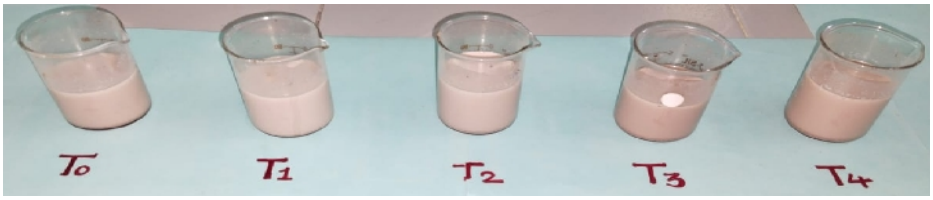


Fig. 3. Nutri-Drink prepared for Sensory evaluation.

Table 6: Organoleptic characteristics of nutri-drink mix.

Sample	Sensory attributes				
	Color and appearance	Taste	Flavor	Texture (Consistency)	Overall acceptability
Control	8.0	8.0	8.1	8.1	8.1
T_1	7.8	7.8	7.8	8.1	7.9
T_2	8.0	7.9	7.6	8.0	8.0
T_3	**8.5**	**8.0**	**8.0**	**8.3**	**8.3**
T_4	7.4	7.2	6.9	7.2	7.5
SE±	0.1200	0.1284	0.0996	0.0925	0.0799
CD @ 5%	0.3642	0.3896	0.3022	0.2808	0.2425

CONCLUSION

Our study demonstrates that the utilization of horsegram malt is a promising functional ingredient for value-addition in nutri-drink mix, as observed by the improvement of the nutritional properties of the mix. Furthermore, the inclusion of the process optimization treatments for better malt yield was done successfully. The effect of malting on chemical composition, anti-nutritionally factors was done well. The incorporation of the malt flour in the developed nutri-drink mix was found acceptable with enhanced overall acceptability.

FUTURE SCOPE

In the future horsegram malt has enormous potential for development into healthy and functional food. Malting reduces antinutritional factors and improve nutritional quality. Production of instant nutri-drink mix is feasible from the economic point of view. The future aspects deal with biochemical and functional characterization of nutri-drink mix incorporated with horsegram malt flour to determine the functional and reconstitution properties of the mix.

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Conflict of Interest. None.

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