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Studies on quality characteristics of ready-to-eat breakfast cereal mix

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Abstract
Black rice and algal oil based ready-to-eat breakfast cereal mix was developed by blending roasted black rice, white rice in grounded form and was mixed with SMP, sugar, cocoa powder and algal oil in different combinations. Roasted black rice and glutinous white rice was mixed in different ratio combinations of 60:40, 70:30, 80:20, 90:10 and 100:00. The samples were analyzed for its physico-chemical properties; organoleptic characteristics and storage properties. The organoleptic analysis of the product was carried out by using 9-point Hedonic scale by a team of five judges. The treatment T_1 was observed to be the optimized treatment based on highest organoleptic scores. The carbohydrate, fat, protein, total solid, ash, crude fibre and titratable acidity of the optimized sample was found to be 66.96, 3.81, 19.69, 94.53, 5.12, 0.52 and 0.245 respectively. The health benefits of black rice can be effectively delivered through this type of developed ready-to-eat breakfast cereal mix. Black rice is rich in antioxidant and prevents diseases associated with chronic inflammation. Consumption of DHA lowers risk of Alzheimer's disease. The DHA also helps for a brain cell development which in turn improves memory and learning ability.

Keywords: Breakfast cereal mix, rice, algal oil, physico-chemical

Introduction
Breakfast is one of the basic meal consumed by human. Breakfast cereals are processed grains and are convenient for human consumption, typically ready-to-eat. However, ready-to-eat cereals are produced by a variation of several technological operations such as cooking, shape forming, finish drying, sweetening, flavouring, enrichment with vitamins and minerals (Caldwell *et al*., 2016) [4]. Nowadays, due to hectic life schedule, in-home preparation time has been reduced and breakfast cereal technology is gaining importance. Worldwide flaked, puffed, shredded, and cooked ready-to-eat cereals are prepared from whole grains or parts of grains of corn, rice, wheat, or oat (Fast R B, 2000) [6]. The potential benefits of omega-3 fatty acids have been widely reported in several areas, including cardiovascular diseases, brain development, atherosclerosis, hypertension, cancer, inflammatory, autoimmune and neurological disorders. Long Chain ω-3 PUFA (LC ω-3 PUFA), specifically, EPA and DHA have anti-inflammatory, antithrombotic and antiarrhythmic properties which can be helpful to prevent atherosclerosis (Moreno *et al.*, 2003) [11] and coronary heart diseases (Mozaffarian *et al.*, 2005) [12]. Antioxidant present in black rice named anthocyanin lowers LDL cholesterol level thus decreasing the chances of atherosclerosis and heart attack, lower blood pressure and keeps our heart healthy. It also inhibits cholesterol absorption, (Ujjawak *et al.*, 2016; Jerzy *et al.*, 2009) [15, 9]. The present study aims to investigate the quality characteristics of ready-to-eat breakfast cereal mix prepared by mixing different combination of black rice and algal oil.

Materials and Methods
Procurement of materials
Roasted black rice and roasted glutinous white rice was collected from local market of Imphal, Manipur. Algal oil was procured from Vasta Biotech, Chennai. Sugar was purchased from local market of Prayagraj. SMP was procured from AMUL. Cocoa powder was procured from Wiekfield, Nalagarh, Himachal Pradesh. Multi mineral mix cum vitamin mix was procured from DSM, Chandigarh.

Preparation of ready to eat breakfast cereal mix
The manufacturing process for preparing the Black rice based ready-eat breakfast cereal mix is discussed below. The two roasted rice were uniformly mixed. Then the rice was heated to 40-45 °C for 5 minutes. The roasted and grounded black rice and white rice were blended with powdered sugar @ 10%, SMP @ 25%, cocoa powder @ 5%, mineral mix cum vitamin mix 2%

and algal oil@ 2%. The product was uniformly mixed. Different treatments were formulated using different ratio of black rice and white rice. The different treatments were T_1, T_2, T_3, T_4 and T_5 having a Black rice: White rice ratio combinations of 60:40. 70:30, 80:20, 90:10 and 100: 00 respectively.

Physico-Chemical analysis

Carbohydrates (%) was determined by Lane- Eyon Method described in IS: 1479, part ii (1961) [7]. Fat analysis was carried out according to the method of AOAC (1990) [2]. Protein estimation of sample was carried out using Kjeldahl method (AOAC, 2000) [1]. The total solid content of the ready-to- eat breakfast cereal mix was estimated by (Ranganna, 2009) [14]. The ash content of Ready-to-eat breakfast cereal mix sample was estimated by the charring method described by AOAC (2000) [1]. Crude fibre (%) of the ready-to-eat breakfast cereal mix sample was estimated by the method given by AOAC (2000) [1]. The Titratable acidity of the ready-to-eat breakfast cereal mix sample was estimated latic acid as described in (Ranganna, 2009) [14].

Loose bulk density, Packed bulk density and Flowability was analysed as per the method as described by Bandyopadhyay *et al*., (2016) [3]. Dispersibility was determined by the method described by Kulkarni *et al*., 1991 [10]. Wettability and oil absorption capacity Emulsification capacity and Gelatinization temperature was estimated as per the method described by Onwuka (2005) [13]. Foaming capacity and stability of the flour samples were studied according to the methods described by Desphande *et al.*, (1982) [5]. The viscosity of the samples was determined with a Brookfield dial viscometer. Insolubility index analysis by the method in IS: SP: 18(Part XI), (1981) [8]. Colour L*, a* and b* (Hunterlab, Hunter Associates Laboratory, Reston, Verginia USA) the values were analyzed by Hunter Colorimeter.

Sensory analysis

The evaluation was done by a 5 trained panelists at Warner College of Dairy Technology, SHUATS, Allahabad. Judgments for ready-to-eat breakfast cereal mix were carried out through rating products on a 9-point hedonic scale (Ranganna, 2009) [14].

Statistical analysis

Statistical analysis all the experiments were conducted in triplicate and the mean and standard deviation were calculated using MS Excel software and WASP. The data were subjected to one-way analysis of variance (ANOVA).

Result and Discussions

In the present investigation the physico-chemical parameters like Carbohydrate, Fat, Protein, Total solid, Ash, Crude fibre and Titratable acidity have been studied. Carbohydrate percent was found to be 66.96, 66.41, 65.93, 65.43 and 64.91 for treatments T_1, T_2, T_3, T_4 and T_5 respectively. Fat percent was observed as 3.81, 3.97, 4.05, 4.30 and 4.33 for treatments T_1, T_2, T_3, T_4 and T_5 respectively. Protein percent was observed as 19.69, 19.93, 20.09, 20.34 and 20.36 for treatments T_1, T_2, T_3, T_4 and T_5 respectively. Total solid percent was observed as 94.53, 94.55, 95.58, 94.61 and 94.64 for treatments T_1, T_2, T_3, T_4 and T_5 respectively. Ash percent was observed as 5.12, 5.16, 5.20, 5.26 and 5.43 for treatments T_1, T_2, T_3, T_4 and T_5 respectively. Crude fibre percent was observed as 0.52, 0.59, 0.68, 0.74 and 0.81 for treatments T_1, T_2, T_3, T_4 and T_5 respectively. Percent titratable acidity was observed as 0.245, 0.249, 0.248, 0.246 and 0.243 for treatments T_1, T_2, T_3, T_4 and T_5 respectively. It was observed that the values of Carbohydrate and Ash content showed an increasing order with the decrease level of black rice and increase level of white rice. Meanwhile for parameters like total solids and titratable acidity the analysis did not show any such pattern of increasing or decreasing order.

The Loose bulk density of T_1, T_2, T_3, T_4 and T_5 were observed as 0.45, 0.44, 0.44, 0.44 and 0.44 respectively. The Packed bulk density values were being found to be 0.56, 0.55, 0.55, 0.55 and were 0.55 respectively. The Flowability were observed to be 1.25, 1.25, 1.25, 1.25 and 1.25 respectively. The Dispersibility were observed as 84.03, 81.15, 79.03. 74.22 and 72.49 respectively. Fat absorption Capacity was observed 1.12,1.20, 1.20, 1.29 and 1.34 respectively. And Foaming capacity were found to be 1.93, 2.10, 2.12, 2.25 and 2.36 respectively. The Emulsification capacity were observed as 58.40, 60.70, 63.00, 65.40 and 66.60 for treatments T_1, T_2, T_3, T_4 and T_5. Gelatinization temperature were observed as 75.00, 76.00, 76.10, 77.50 and 78.00 respectively. The different Viscosity were observed as 0.278, 0.256, 0.238, 0.215 and 0.191 for treatments T_1, T_2, T_3, T_4 and T_5 respectively. Colour L* were observed as 67.23, 66.55, 66.33, 65.78 and 65.69 respectively. The Colour a* were observed as 8.24, 8.42, 8.54, 8.65 and 8.78 respectively. Again Colour b* were observed as 12.16, 12.33, 12.52, 12.65 and 12.79 f respectively. Also Insolubility index were observed as 1.84, 1.80, 1.72, 1.68 and 1.64 for treatments respectively. It is observed that parameters such as Loose bulk density, Packed bulk density, Dispersibility, Viscosity, Colour L* and Insolubility index indicating a decreasing order with every increase of black and decreasing level of white rice. Whereas the results for parameters such as Flowability, Fat absorption capacity. Foaming capacity, Emulsification capacity, Gelatinization temperature, Colour a* and Colour b* showed an increasing order with every increasing level of black rice and decreasing level of white rice.

It was found that the flavour score decreases from 7.00 to 6.52 in case of T_1, T_2, T_3, T_4 and T_5. As the level of black rice increases there was decrease in the flavour scores. For the analysis of Colour and appearance it was observed that the score decreases from 7.80 to 7.40 in case of T_1, T_2, T_3, T_4 and T_5. As the level of black rice increases there was decrease in the Colour and appearance scores. In the analysis for Body and texture it was observed that the score decreases from 7.80 to 7.60 in case of T_1, T_2, T_3, T_4 and T_5. As the level of black rice increases there was decrease in the Body and texture scores. For the analysis of Overall acceptability, it was observed that the score decreases from 7.50 to 7.00 in case of T_1, T_2, T_3, T_4 and T_5. As the level of black rice increases there was decrease in the Overall acceptability scores

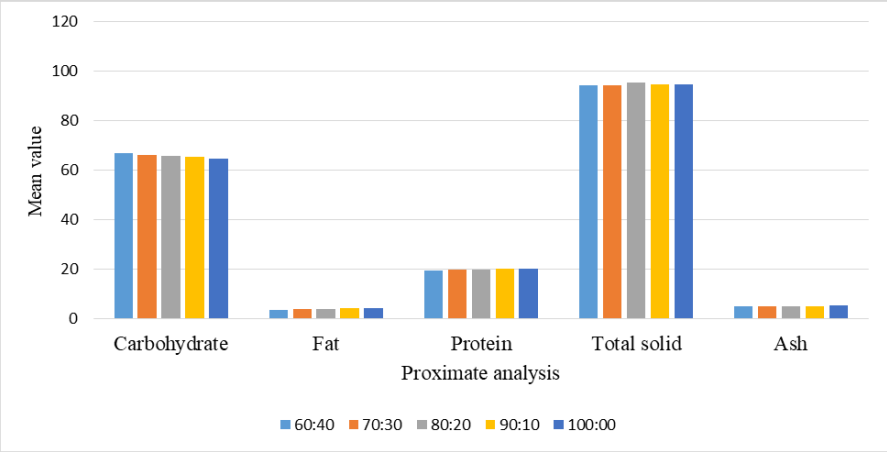

Fig 1: Graph representing the Chemical parameters obtained in different treatments

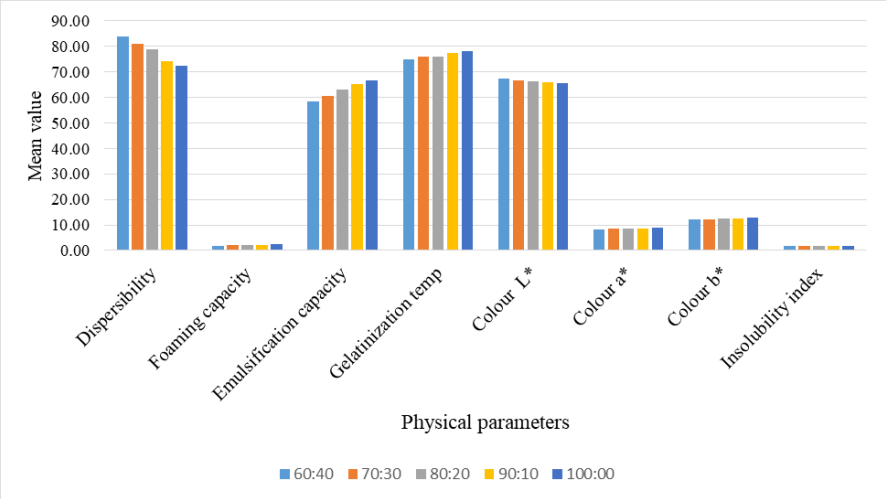

Fig 2: Graph representing average Physical parameters in different treatments

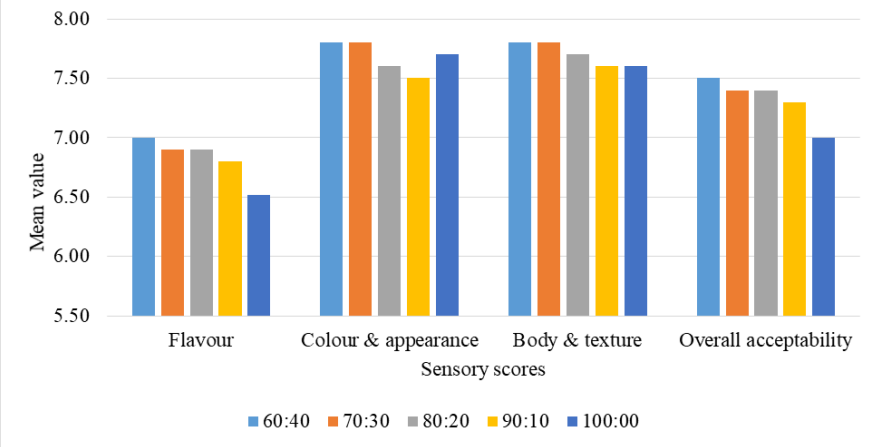

Fig 3: Graph representing average sensory analysis scores in different treatments

Conclusion

The present study revealed that black rice can be successfully utilized for the preparation of ready-to-eat breakfast cereal without affecting the organoleptic properties. Black rice contains anthocyanins, antioxidants, phenols and crude fibre. People deprived of breakfast can consume this type of product in order to get health benefit of black rice.

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