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Staling of chapatti (Indian unleavened flat bread)

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Abstract

Staling in foods is a process, which occurs when starch chains after gelatinization begin to reassociate in an ordered structure. Staling of chapatti results in loss in texture and eating quality of chapatti. Moisture content, water-soluble starch, in vitro enzyme digestibility, enthalpy change (ΔH), texture and sensory quality of chapattis, which are significantly affected during staling both at room and refrigerated temperature storage, were monitored over a storage period of one month. Moisture content, water-soluble starch and in vitro enzyme digestibility were found to decrease steadily during staling of chapattis at both room temperature and refrigerated temperature of storage. Enthalpy change, ΔH, as measured by DSC increased with storage time. The texture of chapattis became progressively harder with storage at both room and refrigerated temperature. A decrease in sensory quality and acceptability of the chapattis was observed with storage. The rate of staling was lower at refrigerated temperature. Most of the staling parameters studied showed good correlation. Texture showed the best overall correlation with all other staling parameters. In general, the correlation obtained at room temperature was better than that at refrigerated temperature.

Keywords: Chapatti; Staling; Water-soluble starch; In vitro enzyme digestibility; Enthalpy change; Texture; Sensory quality

1. Introduction

In India, wheat is one of the daily staples, consumed in different forms of flat breads, such as chapatti, paratha, phulka, tandoori roti and nan. Just as bread is a staple food item in the Western World, chapatti, is a staple food of a majority of the population in many regions of the Indian subcontinent. Almost 90% of the wheat produced in India is consumed in the form of chapatti. Only 10% of the wheat produced in India is consumed in making bread/biscuits/cake and such other products. Chapattis are generally prepared twice a day for lunch and dinner, and unless eaten immediately after preparation, these stale rapidly and become difficult to chew. The most important parameters of chapatti quality are texture and flavour. The former is generally evaluated in terms of tenderness, flexibility and ability to be folded into a spoon shape for eating with curried preparations but the flavour is judged mainly in terms of sweetish taste and fresh typical wheatish aroma.

The increasing demand for convenience food (Raghavan, 1994) because of urbanization and industrialization, has, however, created a need to mechanize the preparation of chapatti for marketing in unit packs, similar to bread. Freshly-baked chapattis are soft, pliable and elastic but when kept at room temperature they stale within few hours and become tough and rigid. Staling of chapattis has not been extensively studied though a few reports are available (Nanjappa, Jagannath, & Arya, 1999). In view of the fact, that chapattis may be manufactured on a large mechanized scale and distributed, the staling of chapattis may become a critical factor for consideration.

Cooking (or processing) normally causes starch gelatinization, i.e. irreversible swelling or even disruption of the starch granules, depending on the severity of the treatment applied. The behaviour of gelatinized starches on cooling and storage, generally termed as retrogradation, is of great

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interest to food scientists and technologists since it profoundly affects quality, acceptability and shelf-life of starch-containing foods (Biliaderis, 1991). Starch molecules in pastes or gels are known to re-associate on aging, resulting in effects such as precipitation, gelation, and changes in consistency and opacity. Crystallites eventually begin to form, and this is accompanied by gradual increase in rigidity and separation between polymer and solvent (syneresis). It is important to distinguish between the short-term development of gel structure via amylose crystallization and long term reordering of amylopectin, which is a much slower process involving recrystallisation of the outer branches (DP = 15) of this polymer (Miles, Morris, Orford, & Ring, 1985; Ring et al., 1987). For common starches containing both amylose and amylopectin, a composite gel network forms, consisting of swollen amylopectin-enriched granules (provided granule integrity is maintained) filling an interpenetrating amylose gel matrix (Miles et al., 1985). During long term storage, amylopectin recrystallizes, thus increasing the rigidity of the swollen granules, which in turn, reinforces the continuous amylose phase. The effect of retrogradation in starch-based products can be desirable or, more usually, undesirable. The undesirability of staled starch is because it results in the formation of hard texture, which directly affects the quality of the final products.

The rate of retrogradation (staling) has been studied by different physicochemical methods. The increase in enthalpy change or shift in endotherm measured by DSC has mostly been used by investigators following bread staling. Other physical changes, such as crumb firmness, loss in flavour, X-ray diffraction and chemical methods, namely starch solubility (iodine affinity), enzyme digestibility, moisture content, have also been used. Chapatti is highly susceptible to staling as compared to bread. Extensive work has been reported on staling of bread. However, the literature on the rate of staling of Indian traditional foods, such as chapatti and phulka, is limited.

The purpose of this study was to investigate the different physicochemical parameters for the evaluation of staling of chapattis. Multiple correlations were established to determine the significance of each parameter in the measurement of staling of chapatti.

2. Materials and methods

2.1. Materials

Branded whole wheat flour (Nature Fresh atta), double-filtered groundnut oil (Dhara), and table salt (Tata salt) were procured from the local market. Preservatives, such as calcium propionate, were procured from CDH Laboratory, Mumbai, India, and potassium sorbate and citric acid were obtained from Hi media, Mumbai, India. Amyloglucosidase was donated by Biocon, Bangalore, India. All the other chemicals used for the analysis were of analytical grade.

2.2. Proximate analysis of atta

The proximate analysis of the branded whole-wheat flour (atta) was carried out as follows:

Moisture content was determined by the AACC (1976) method. Total fat, total ash, acid insoluble ash, crude fibre, dry gluten and protein content were determined by the AOAC method (AOAC, 1975).

2.3. Preparation of chapatti

The whole-wheat flour (100 g) were mixed with 62 ml of water containing 0.2% potassium sorbate, 0.2% calcium propionate, 0.3% citric acid and 2% of salt, all on flour weight basis. This was all kneaded for 5 min to form dough. Then 5% of groundnut oil was added and the dough was again kneaded so that the oil is completely mixed with the dough. The dough was then covered with a wet cloth and allowed to rest for 10 min. It was again kneaded for 1 min. Then 30 g of dough were rolled into a diameter of 15 cm and thickness of approximately 2 mm. The dough was then baked on a preheated griddle under controlled flame on one side for 45 s and the other side for 60 s. It was then puffed directly on a maximum flame for 10 s on both sides. Hot chapatti was then precooled on a hollow wooden stand for about 5 min. Chapatti was then cooled to room temperature and stored in a self-sealing low density polyethylene (LDPE) 60 gauge plastic bag.

2.4. Evaluation of chapatti for staling during storage

2.4.1. General

Chapattis were prepared from whole wheat branded atta, as described earlier, and were periodically evaluated for moisture content, water-soluble starch (WSS), in vitro enzyme digestibility (IVED), enthalpy change (ΔH), texture, colour and sensory analysis during one month of storage at room temperature (29 ± 1 °C) and refrigerated temperature (4 ± 1 °C). In the case of refrigerated chapattis, before analysis, they were brought to room temperature.

2.4.2. Moisture content

Moisture content of chapattis was determined by using a two stage-drying method. In the first stage, 5–7 g of the chapatti sample were taken and kept in an air-oven at 103 °C for 4 h. In the second stage, air-dried samples were ground and 2–3 g of this ground sample were again dried using a first stage drying method (AACC, 1976).

2.4.3. Water soluble starch (WSS)

Percentage of total water-soluble starch (WSS) was determined by a modified procedure of Morad and D'Appolonia (1980). Chapatti (200 mg) was extracted with 15 ml of distilled water by agitating the mixture on a shaker for 20 min. The slurry was centrifuged at 5000 rpm for 5 min and the supernatant filtered. The filtrate (10 ml)