**DEVELOPMENT AND QUALITY EVALUATION OF BISCUITS BY USING SHATAVARI POWDER AND EMMER WHEAT FLOUR**

**ABSTRACT**

The increasing interest in nutritious and functional foods has led to the investigation of alternative grains with enhanced health benefits. This research enters on developing nutritious biscuits using shatavari powder and emmer wheat. The food intake by such people is of substandard with respect to nutritive value and often leads to some disorder. Common and easy to eat food for such people is biscuit. The advantages of certain ayurvedic herbs are well documented in literature. Low-cost nutritive biscuits made of ayurvedic components shatavari powder were developed. It is rich in carbohydrate, energy, protein and fat which add to its medicinal importance for malnourished population. Newly formulated biscuits were investigated for its chemical and sensory characteristics by method reported in the literature. These grains are cultivated for their good nutritional values, such as high protein, essential minerals, and bioactive compounds, making them ideal for creating shatavari powder and emmer wheat seeds were investigated. Blends of shatavari powder and emmer wheat were carried out, with proportions of emmer wheat to shatavari powder being 96:4, 94:6 and 92:8. Temperature is 140°C, 150°C and 160°C.Time is 10, 12 and 14 min. The seventeen trials of biscuits formulation in based on proportion, temperature and time. Physical, chemical and sensory evaluation of all the samples was performed. Analytical methods were used to evaluate the nutrient composition, including protein, fibre, and mineral content. Sample T13 was (EW: S-96:4, Temperature 150°C and Time 12 min) selected for storage study of 90 days. The data obtained from sensory and proximate analysis in the present investigation are sufficient to conclude that shatavari powder is an effective substitute for wheat flour in biscuits preparation. This substitution increased the protein content of the biscuits. The biscuits made with a 40% replacement of wheat flour with shatavari powder flour were the most acceptable.

***Keywords:*** Biscuits, Shatavari Powder, Emmer Wheat, RSM, Chemical Composition

**1. INTRODUCTION**

**1.1 Bakery Industry**

The growing demand for processed foods, driven by convenience and changing socio-economic conditions, has boosted the popularity of ready-to-eat products. Biscuits, a widely consumed bakery item in India, make up a significant portion of the country's bakery consumption. Despite their widespread use, per capita biscuit consumption in India remains lower than in developed nations (Mehta, 2013). Biscuits are a popular and affordable bakery product consumed across all age groups due to their convenience, nutritional value, and energy benefits. They are made using ingredients like refined wheat flour, sugar, butter, and baking agents, and can be enhanced with Ayurvedic herbs for added medicinal value. As a ready-to-eat food, biscuits serve as a dietary supplement, providing essential nutrients like protein, iron, and calcium. The Indian bakery sector is growing rapidly, driven by consumer demand for healthier, organic, and nutritious options. (Jamuna 2012). Biscuits and sweet baked goods are high in sugar and fat, making them less desirable for calorie-conscious consumers. Their functional properties can be enhanced by modifying key ingredients like flour, sugar, and fat. Healthier alternatives include whole multigrain flour, artificial sweeteners, fat replacers, and supplements like whey protein concentrate, skimmed milk powder, and dietary fiber. These modifications improve the nutritional value of biscuits while maintaining their taste and texture. (Aggarwal 2016) The bakery industry is growing due to factors like population growth, globalization, rising working women, and changing eating habits. Baking remains a key part of the food processing sector, with increasing consumer demand for diverse and healthier options. The industry is adapting by fortifying products to cater to health-conscious consumers. ( Majid 2017) Baked goods are popular due to their availability, long shelf life, and convenience. Their low moisture content reduces microbial spoilage, enabling large-scale production and distribution. Common bakery products include bread, cakes, pastries, biscuits, and muffins, with biscuits being a widely consumed snack among both adults and children. The market competition has driven efforts to enhance the nutritional quality of biscuits. Made from ingredients like flour, water, sugar, and oil, biscuits differ from bread dough. Cereals and bakery products are essential in emergency meals due to their affordability and high-calorie content. However, prolonged consumption of cereal-based diets can lead to nutrient deficiencies, as cereals lack sufficient vitamins, minerals, and essential amino acids.

**1.2 Shatavari**

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Asparagus racemosus, also known as Shatavari, is a perennial climbing shrub with medicinal properties.It is an indigenous plant to South Asian countries and has been used in traditional systems of medicine.Shatavari contains phytoestrogens, saponins, and steroidal glycosides, making it a natural hormone precursor. It is considered a general tonic and female reproductive tonic, promoting love and devotion. Shatavari is effective in treating female reproductive issues, infertility, and menopausal symptoms. It also has anti-inflammatory, antioxidant, and properties. Shatavari root powder has been found to have nutritional benefits, including protein, dietary fiber, and minerals. The herb has been used to treat various health issues, including ulcers, diarrhea, and respiratory problems. Shatavari is considered a rasayana in Ayurveda, promoting overall health and well-being. It is also used as a galactogogue, nervine tonic, and antacid, among other therapeutic uses. Asparagus racemosus, a perennial climbing shrub belong to the family Asparagaceae and sub family Liliaceous (Chadha, 2003). It is an indigenous medicinal plant originated to South Asian countries. Its medicinal properties have been reported in traditional systems of medicine such as Ayureda, Siddha and Unani and have been utilized for primary health care of people since time immemorial. Mostly the roots (powder or extract) of this plant have been used for medicinal purpose under popular local name as ‘Shatavari or Shatavar. The roots are fleshy, whitish brown in colour and slightly sweet in taste, however powder obtained from dried roots imparts a slightly bitter after taste. This herb is highly effective in problems related to female reproductive system (Kumari *et al., 2016*) and therefore it is also known as ‘women’s herb’ blessed to cure all the ailments of female hormonal problems. It has been investigated by a number of researchers that its roots (powder and extracts) have an ability to improve lactation performance in lactating mothers . Research on the administration of shatavari root powder or extracts demonstrated a significant increase in milk secretion with increased growth of the mammary glands and alveolar tissues in mammals. Other than lactogenic, it was also effective in ameliorating dysmenorrhea as it contain saponins which hinder the oxytocic activity on uterine musculature, thereby maintain the spontaneous uterine motility, confirming its utility in dysmenorrhea. The plant is also beneficial in female infertility, as it enhances folliculogenesis and ovulation, prepares the womb for conception and prevents miscarriages. In recent years, it has become the most important ingredient to be added in female health tonic.

**1.3 Emmer Wheat**

Wheat is a staple food crop for over a third of the world's population, providing calories, proteins, and essential nutrients. It is a good source of protein, minerals, B-group vitamins, and dietary fiber.Wheat flour is used to prepare various food products, including bread, biscuits, and noodles. Whole-wheat bread is considered a healthy food option. Wheat grains are rich in pantothenic acid, riboflavin, and minerals like selenium and magnesium. Emmer wheat, an ancient wheat variety, is rich in vitamins, minerals, carotenoids, fiber, proteins, and antioxidant substances. It has higher protein content and resistant starch compared to common wheat. Emmer wheat is suitable for people with gluten sensitivities and is used in sourdough bread production. It is also used to make pasta, beer, and functional beverages. Wheat is an essential crop, providing nutrition to millions of people worldwide. Wheat is the most important staple food crop for more than one third of the world population and contributes more calories and proteins to the world diet than any other cereal crops*.* It is nutritious, easy to store and transport and can be processed into various types of food. Wheat is considered a good source of protein, minerals, B-group vitamins and dietary fibre although the environmental conditions can affect nutritional composition of wheat grains with its essential coating of bran, vitamins and minerals; it is an excellent health-building food. Wheat flour is used to prepare bread, produce biscuits, confectionary products, noodles and vital wheat gluten or seitan. Wheat germ and wheat bran can be a good source of dietary fibre helping in the prevention and treatment of some digestive disorders. The antioxidant activity and phytochemical content were studied in milled grain of eleven varieties which included a range of red and white wheat and durum wheat. Whole-wheat bread is good for health. The key characteristic, which has given it an advantage over other temperate crops, is the unique properties of dough formed from wheat flours, which allow it to be processed into a range of breads and other baked products (including cakes and biscuits), pasta and noodles, and other processed foods. Lutein is the predominant carotenoids present in wheat and the bran/germ fractions of wheat contained greater amounts of carotenoids and antioxidant activity than the endosperm fractions. Lutein, along with zeaxanthin, is important for the health of skin and eyes in humans (Kumar *et al.*, 2011).

**2. MATERIALS AND METHODS**

**2.1 Materials**

The material required for the research was selected carefully and with reference to previous researches. The material selected was easily available in the local market .The material such as shatavari powder, emmer wheat, milk, Jaggery powder, ghee, baking powder, sodium bicarbonate, essence, and packaging material. Packaging materials i.e. aluminium foil bags were procured from local market, Kolhapur. The equipment and instruments used in the present study during development of biscuits from shatavari powder and emmer wheat are vernier calliper, hammer mill, kneader, electronic weighing balance, hot air oven, muffle furnace, Kjeldahl apparatus, Soxhlet apparatus, Automatic Solvent Extraction Unit, Hand operated packaging machine.

**2.2 Methods**

**Physical properties of raw material (Shatavari powder and Emmer wheat)**

Physical properties of shatavari powder and emmer wheat (DDK - 1029) include length; thickness and diameter were evaluated using a vernier calliper of about 0.01mm precision. The average seed size was then calculated. The weight of 100 seeds randomly selected was determined by weighing (AOAC, 2000). The average seed weight was then calculated. A measuring cylinder was used to measure the seeds' respective densities. The volume increase was observed when 100 seeds of a specified weight were submerged in 200 ml of distilled water in the measuring cylinder. The following equation was used to compute the relative density,

**Proximate analysis of raw materials (shatavari powder and emmer wheat)**

The nutritional parameters of shatavari powder and emmer wheat such as moisture, protein, fat, fibre and ash were determined by using standard methods (AOAC, 2000). Carbohydrates for shatavari powder and emmer wheat was calculated by difference method equation as follows,

Carbohydrates (%) =100 – % (Moisture + Fat + Protein + Ash + Crude fibre) … (2)

The energy value of food is typically calculated based on the macronutrient content: carbohydrates, proteins and fats. The formula for calculating the energy values:

Energy (kcal) = (carbohydrate×4) +(protein×4) + (fats×9) …(3)

**2.3 Development of biscuits**

**Development of Biscuits by Using Shatavari Powder and Emmer Wheat**

Table 1 presents seventeen distinct trials with varying blends of shatavari powder and emmer wheat for biscuits production. The trials range from 8% shatavari powder (T1) to 4% shatavari powder (T17), including several intermediate proportions as per previous research (Nwakalor, 2014; El-Gohery, 2021) and trial basis. These different blend formulations are intended to assess how shatavari powder affects the final product’s characteristics. By evaluating these varying blends, we aim to identify the optimal combination that provides the desired taste and nutritional benefits. The formulations of biscuits by using Box behnken design method.

**Table 1: Formulation of Biscuits**

|  |  |  |  |
| --- | --- | --- | --- |
| **Sr. No.** | **Proportion (EW:S)** | **Temperature**  **°C** | **Time** |
| 1 | 96:04 | 140 | 10 |
| 2 | 94:06 | 150 | 12 |
| 3 | 92:08 | 160 | 14 |

**Table 2: Formulation of Biscuits Seventeen Trials**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Treatment** | **Proportion** | | **Minutes** | **Temperature**  **°C** |
| **Emmer Wheat (%)** | **Shatavari Powder (%)** |
| T1 | 94 | 6 | 10 | 160 |
| T2 | 94 | 6 | 14 | 140 |
| T3 | 94 | 6 | 12 | 150 |
| T4 | 96 | 4 | 12 | 160 |
| T5 | 92 | 8 | 10 | 150 |
| T6 | 94 | 6 | 12 | 150 |
| T7 | 96 | 4 | 12 | 140 |
| T8 | 94 | 4 | 12 | 150 |
| T9 | 94 | 6 | 12 | 150 |
| T10 | 94 | 6 | 12 | 150 |
| T11 | 92 | 8 | 12 | 140 |
| T12 | 94 | 6 | 10 | 140 |
| T13 | 96 | 4 | 12 | 150 |
| T14 | 96 | 4 | 10 | 150 |
| T15 | 94 | 6 | 14 | 160 |
| T16 | 96 | 4 | 14 | 150 |
| T17 | 92 | 8 | 12 | 160 |

Data are expressed as mean ± standard deviation of triplicate experiments (n=3)

**2.4 Preparation of Biscuits**

The flow chart 1 shows that preparation of biscuits and Powdered Jaggery and shortening were blended together. Ammonium bicarbonate; sodium bicarbonate and composite flour were combined as the dry ingredients. After thorough mixing, a uniform paste of jaggery and shortening was created. The mixture was carefully kneaded by hand after the necessary amount of milk was added. Using a cutter, the dough was shaped into uniform pieces and rolled to a thickness of 3 to 5 mm to form round biscuits. The biscuits were then baked at 150°C for 12 minutes

Weighing of flour and ingredients (as per formulation)

Mixing of ingredients in flour

Kneading of dough (kneader)

Making small balls rolling into sheet (3-5 mm)

Cutting of dough sheet in desired shape with cutter

Place the biscuits in preheated oven

Baking of biscuits at 150°C for 12 min.

Cooling of baked biscuits at room temperature

Biscuits

**Fig. 1: Flow Chart for Preparation of Biscuits**

**2.5 Quality Evaluation of Prepared Biscuits**

Quality evaluation of all prepared biscuits was carried out which include physical evaluation, sensory evaluation and proximate analysis. Physical evaluation includes weight, diameter, and thickness and spread ratio. Three pieces of biscuits from each trial was randomly selected. The dimensions like width, thickness will be measured with digital vernier calliper (accuracy of 0.001 mm) and weight of sample biscuits was measured using sensitive weighing balance. Mean of three determinations was recorded. Spread ratio of biscuits is the ratio of average value of diameter to the average value of thickness. The biscuits sample have been evaluated for different sensory attributes such as appearance, colour, flavour, taste and overall acceptability by using 9-point Hedonic scale with the help of panel. The mean of observations has been considered for evaluating the quality of prepared biscuits.

**2.6 Storage Studies of Developed Biscuits**

One sample out of seventeen was selected on the basis of physical and sensory analysis. The selected biscuits were packed in aluminium foil bags packages and stored at room temperature. The nutritional and microbial evaluation of biscuits is evaluated at an interval of 15 days for a period of 90 days. Microbial examination is the perfect quality assessment protocol performed in food products quality analysis. In the study of microbial quality Total Plate Count were examined for developed biscuits. Using Total Plate Count Agar (Nutrient Agar) containing, the total plate count of biscuits was calculated. The aliquot of 0.1 ml was used for the isolation; and the dilutions were made up to 104. With the aid of laminar air flow, every procedure was completed in a completely sterile environment. Results were expressed in CFU/ml after 48 hours of incubation on plates at 370 C. Every fifteen days, the biscuits' total plate count (TPC) was analysed (Chandru et al., 2013).

**3. RESULT AND DISCUSSION**

**3.1 Physical Properties of Shatavari Powder and Emmer Wheat Seeds**

Physical properties of emmer wheat seeds including length is 10.63mm, width is 4.2 mm, thickness 2.3 mm and bulk density is 725 kg/m³. A functional property of shatavari powder and emmer wheat water absorption capacity is 200 % and 66% respectively. Shatavari powder and emmer wheat oil absorption capacity is 100 % and 44.7% respectively. Shatavari powder and emmer wheat bulk density is 0.6 kg/m³ and 0.38 kg/m³ respectively**.**

**3.2 Proximate Composition of Shatavari Powder and Emmer Wheat**

Proximate analysis of shatavari powder has significantly lower protein content (2.47%) compare to emmer wheat (17.72%). Proximate analysis of shatavari powder and emmer wheat moisture is 9.5% and 1.60% respectively. Proximate analysis of shatavari powder and emmer wheat ash is 3.55% and 1.78% respectively. Proximate analysis of shatavari powder and emmer wheat fat is o.11% and 2.95% respectively. Proximate analysis of shatavari powder and emmer wheat fiber is 2.5 % and 0.33 % respectively. Proximate analysis of shatavari powder and emmer wheat carbohydrate is 3.39% and 75.92% respectively.

**3.3 Physical Properties of Biscuits**

Table 3 presents the physical characteristics of developed biscuits. The parameters measured include Weight, Diameter, Thickness and Spread Ratio of the biscuits. The values for each replication are provided alongside the calculated Mean.

**Table 3.: Analyzed Physical Properties of Biscuits**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Treatments** | **Weight** | **Diameter** | **Thickness** | **Spread Ratio** |
| T1 | 10.2 | 39.2 y | **577.77** 7.5 | 5.22 |
| T2 | 11 | 39.6 | 7.8 | 5.07 |
| T3 | 10.8 | 39.2 | 7.5 | 5.22 |
| T4 | 10.4 | 44.3 | 6.3 | 7.03 |
| T5 | 11.05 | 43.3 | 6.3 | 6.87 |
| T6 | 10.5 | 42.8 | 6.8 | 6.29 |
| T7 | 11 | 43.9 | 6.8 | 6.45 |
| T8 | 11.5 | 41.5 | 6.5 | 6.38 |
| T9 | 10.5 | 42.5 | 6.9 | 6.15 |
| T10 | 11.5 | 43.8 | 6.8 | 6.44 |
| T11 | 11.7 | 44.2 | 6.4 | 6.9 |
| T12 | 10.5 | 38.6 | 7.5 | 5.14 |
| T13 | 10 | 43.8 | 7.9 | 5.54 |
| T14 | 10.5 | 42.6 | 7.2 | 5.91 |
| T15 | 10.2 | 43.5 | 7.1 | 6.12 |
| T16 | 10.1 | 43.5 | 7.1 | 6.12 |
| T17 | 10.3 | 43.4 | 7.4 | 5.86 |
| **Mean** | 10.69117647 | 42.53125 | 7.01875 | 6.041764706 |
| **SD** | 0.521486845 | 1.835108989 | 0.508879488 | 0.629218119 |
| **CV (%)** | 4.877731149 | 4.314730906 | 7.250286561 | 10.41447573 |

Data are expressed as mean ± standard deviation of triplicate experiments (n=3)

**3.4** **Sensory Evaluation of Biscuits Incorporated with Shatavari Powder and Emmer Wheat Flour**

Following the sensorial evaluation using a 9-point hedonic scale for the sensory characteristics like color and appearance, texture, taste, flavor and overall acceptability, various and random trials with a wide range of incorporation levels have been conducted in order to study the effect of shatavari powder flour and emmer wheat on sensorial quality characteristics of biscuit. Table 4. provides an overview of the impact of adding shatavari powder at different percentages (4%, 6% and 8%) on the sensory quality characteristics

**Table 4. Sensory Analysis of All Prepared Samples**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Treatments** | **Appearance** | **Colour** | **Texture** | **Flavour** | **Taste** | **Overall**  **Acceptability** |
| T1 | 6.5 | 7 | 6.9 | 6.5 | 6 | 6.5 |
| T2 | 4.2 | 5.8 | 5.5 | 5.3 | 5.2 | 5.3 |
| T3 | 5 | 6.3 | 6.4 | 5.9 | 5.5 | 5.5 |
| T4 | 6.5 | 7.3 | 6.8 | 6.5 | 6.5 | 6.5 |
| T5 | 5 | 6.3 | 6.4 | 5.9 | 5.5 | 5.5 |
| T6 | 5.7 | 6.2 | 5.6 | 5.9 | 5.5 | 5.9 |
| T7 | 4.3 | 5.3 | 5.4 | 8.8 | 5.4 | 5.4 |
| T8 | 5 | 6.3 | 6.4 | 5.9 | 5.5 | 5.5 |
| T9 | 5.1 | 6.3 | 5.3 | 5.4 | 5.4 | 5.4 |
| T10 | 5 | 6.3 | 6.4 | 5.9 | 5.5 | 5.5 |
| T11 | 4 | 5.4 | 4.8 | 5.1 | 5.5 | 5.5 |
| T12 | 4.5 | 5 | 4.2 | 4.8 | 4.9 | 4.5 |
| T13 | 5.3 | 6.7 | 6.7 | 5.3 | 6.5 | 6.8 |
| T14 | 5.4 | 5.9 | 6.5 | 6.2 | 6.6 | 6.6 |
| T15 | 6 | 5.5 | 5.8 | 5.2 | 6.4 | 5.5 |
| T16 | 5.2 | 6.6 | 6.3 | 5.4 | 6.6 | 6.5 |
| T17 | 6.6 | 7.1 | 6.2. | 6.4 | 6.8 | 6.2 |
| **Mean** | 5.252 | 6.194 | 5.962 | 5.905 | 5.841 | 5.8 |
| **SD** | 0.7961 | 0.6494 | 0.769 | 0.902 | 0.594 | 0.616 |
| CV (%) | 15.15 | 10.48 | 12.90 | 15.27 | 10.18 | 10.62 |

Data are expressed as mean ± standard deviation of triplicate experiments (n=3).

Based on the sensory evaluations we can clearly see that Sample T13 stands out as the best treatment overall. It consistently received high scores across all attributes, including Appearance (5.3), Color (6.5), Texture (5.3), Flavor (6.3), Taste (6.5) and Overall Acceptability (6.5), resulting in the highest mean score of 8.2. Sample T17 closely follows with slightly lower scores in Flavor (6.3) but otherwise similarly high scores in other attributes, achieving a mean score of 6.5. Compared to the other samples, T13's consistently superior evaluations across all sensory attributes make it the most favorable treatment.

Sample T13 was selected for physical and chemical analysis among all the samples after sensory analysis

**3.5 Proximate Analysis of Developed Biscuits**

The present investigation was carried out to study the quality characteristics of biscuit. Biscuit were subjected to proximate analysis and the data pertaining to proximate composition of biscuits are summarized in Table 5.

**Table 5: Proximate Analysis of Prepared Biscuits**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Treatments** | **Moisture (%)** | **Ash (%)** | **Protein (%)** | **Fat (%)** | **Fibre (%)** | **Carbohydrate (%)** | **Energy (Kcal/100g)** |
| T1 | 3.20 | 1.98 | 10.02 | 10.90 | 0.67 | 62.13 | 452.32 |
| T2 | 3.92 | 1.99 | 10.05 | 11.40 | 0.65 | 62.15 | 452.17 |
| T3 | 4.01 | 2.05 | 10.48 | 11.60 | 0.64 | 61.89 | 451.79 |
| T4 | 3.12 | 1.90 | 9.90 | 10.86 | 0.62 | 62.20 | 451.94 |
| T5 | 4.25 | 2.05 | 10.64 | 11.22 | 0.64 | 62.74 | 452.03 |
| T6 | 4.02 | 1.92 | 10.48 | 11.60 | 0.72 | 61.89 | 452.32 |
| T7 | 4.40 | 2.02 | 10.77 | 11.40 | 0.70 | 62.38 | 452.17 |
| T8 | 4.01 | 2.05 | 10.48 | 11.60 | 0.64 | 61.89 | 451.79 |
| T9 | 4.01 | 2.05 | 10.48 | 11.60 | 0.64 | 61.89 | 451.94 |
| T10 | 4.01 | 2.05 | 10.48 | 11.60 | 0.64 | 61.89 | 452.03 |
| T11 | 4.32 | 2.02 | 10.05 | 10.95 | 0.70 | 63.04 | 452.17 |
| T12 | 4.28 | 2.02 | 9.98 | 10.90 | 0.68 | 62.40 | 451.79 |
| T13 | 3.96 | 2.02 | 10.93 | 11.60 | 0.65 | 62.30 | 491.80 |
| T14 | 4.16 | 2.01 | 10.85 | 11.50 | 0.60 | 62.45 | 452.17 |
| T15 | 3.08 | 1.19 | 10.20 | 11.40 | 0.64 | 63.07 | 452.03 |
| T16 | 4.20 | 2.03 | 10.90 | 11.20 | 0.63 | 62.50 | 452.17 |
| T17 | 3.16 | 1.99 | 10.18 | 11.15 | 0.64 | 62.45 | 451.79 |
| **Mean** | 3.8888 | 1.961 | 10.404 | 11.32 | 0.652 | 62.309 | 454.377 |
| **SD** | 0.4495 | 0.203 | 0.3413 | 0.282 | 0.0311 | 0.3820 | 9.6451 |
| **CV (%)** | 11.5608 | 10.37 | 3.2804 | 2.494 | 4.7749 | 0.61321 | 2.1227 |

Data are expressed as mean ± standard deviation of triplicate experiments (n=3).

Table 5 shows that proximate analysis of prepared biscuits across 17 treatments (T1 to T17) revealed variations in moisture, ash, protein, fat, fibre, carbohydrate content, and energy. The average moisture content was 3.89%, with a standard deviation (SD) of 0.45 and a coefficient of variation (CV) of 11.56%, indicating moderate variability in moisture levels. The ash content averaged 1.96%, with an SD of 0.20 and a CV of 10.38%, reflecting consistent mineral content. Protein content had a mean value of 10.40%, an SD of 0.34, and a low CV of 3.28%, indicating stability across treatments. Fat content averaged 11.32%, with an SD of 0.28 and a CV of 2.49%, showing minimal variation. The fiber content was relatively low, with a mean of 0.65%, an SD of 0.03, and a CV of 4.77%. Carbohydrate content, the predominant macronutrient, averaged 62.31%, with an SD of 0.38 and a CV of 0.61%, demonstrating high consistency. The energy value of the biscuits was consistent, with an average of 454.38 Kcal/100g, an SD of 9.65, and a CV of 2.12%. Overall, the biscuits showed minimal variation in macronutrient and energy content, while moisture and ash content exhibited slightly higher variability, likely due to differences in processing conditions or ingredient composition.

Sample T13 was selected for physical and chemical analysis among all the samples after sensory analysis.

**3.6 Storage Study of Developed Biscuits**

Table 6 shows that biscuits proximate composition (moisture, ash, protein, fat, fibre and carbohydrates) changes over 90 days of storage with increasing moisture and decreasing protein and fat observed.

**Table 6: Storage Study of Developed Biscuits**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Storage Period (Days)** | **Moisture (%)** | **Ash**  **(%)** | **Protein (%)** | **Fat**  **(%)** | **Fibre (%)** | **Carbohydrate (%)** |
| 0 | 3.96± 0.05 | 2.02±0.02 | 10.93± 0.02 | 11.60± 0.04 | 0.65±0.01 | 62.30±0.52 |
| 15 | 4.30± 0.03 | 1.98±0.01 | 10.38± 0.04 | 11.40± 0.04 | 062.± 0.01 | 62.45± 043 |
| 30 | 4.55± 0.03 | 1.85±0.01 | 10.22± 0.04 | 11.29± 0.03 | 0.60± 0.02 | 62.63± 0.48 |
| 45 | 4.80± 0.04 | 1.75±0.02 | 10.18± 0.05 | 10.60± 0.05 | 0.55± 0.01 | 62.78± 0.51 |
| 60 | 5.29± 0.04 | 1.7± 0.02 | 10.15± 0.04 | 10.38± 0.02 | 0.52± 0.02 | 62.93± 0.44 |
| 75 | 5.50± 0.04 | 1.69±0.02 | 9.90± 0.04 | 10.30± 0.04 | 0.48± 0.02 | 63.12±0.02 |
| 90 | 5.65± 0.04 | 1.64±0.02 | 9.93± 0.04 | 10.16± 0.05 | 0.45± 0.02 | 63.27± 0.02 |

Storage analysis of biscuits proximate composition (moisture, ash, protein, fat, fibre and carbohydrates) changes over 90 days of storage with increasing moisture and decreasing protein and fat observed. Storage study of 90 days developed biscuits also evaluated. Initially, the moisture content was 3.96%, gradually increasing to 5.65% by day 90, indicating water absorption over time. The ash content, representing minerals, showed a slight decrease from 2.02% to 1.64%. Protein content slightly dropped from 10,93% to 9.93%, while fat content experienced a more significant reduction, starting at 11.60% and falling to 10.16%, with the most notable decline occurring between day 30 and day 75. Fibre content decreased from 0.65% to 0.0.45% by day 75 and remained stable afterward. Carbohydrate content fluctuated, beginning at 62.30%, peaking at 69.59% on day 75 and slightly decreasing to 67.91% by day 90. Consequently, the energy content decreased from 451.79 kcal/100g to 431.66 kcal/100g, reflecting the overall changes in the macronutrient composition. This study shows that the biscuits gained moisture and lost fat, protein, fibre and energy over the storage period, with carbohydrate content showing minor fluctuation.

**3.7 Microbial Analysis of Biscuits**

Microbial analysis in which total plate count of developed biscuits (T13) was carried out at the interval of 15 days up to 90 days by using serial dilution method. Total viable counts were used as a measure of microbiological quality with respect to the levels of the general microbial contamination. Microbiological studies conducted for developed biscuits sample revealed that total plate count of these biscuits was 8× 101 to 35× 103 from 0 to 90 days of storage. These findings showed that developed biscuits were acceptable and their contamination level was still within acceptable limit. These results are similar with the results obtained by (Banusha & Vasantharuba 2014, chopra *et al*., 2014).

**4. SUMMARY AND CONCLUSION**

**4.1 Summary**

Shatavari powder is a nutritious ingredient that can enhance the nutritional value of bakery products. It contains high-quality protein, minerals, and low saturated fat, making it an excellent supplement. Shatavari powder was incorporated into biscuits at 4%, 6%, and 8% levels, replacing emmer wheat flour. The 4% substitution level received the highest scores for taste, flavour, and overall acceptability. Physical properties of emmer wheat seeds and shatavari powder were analyzed, including length, width, thickness, and bulk density. Proximate analysis of shatavari powder and emmer wheat revealed significant differences in protein, moisture, ash, fat, fiber, and carbohydrate content. Biscuits developed with shatavari powder and emmer wheat flour were evaluated for physical characteristics, proximate analysis, and sensory evaluation. The biscuits were stored for 90 days, during which their proximate composition changed, with increasing moisture and decreasing protein and fat. The study suggests that shatavari powder can be used to develop nutritious biscuits with enhanced nutritional value. The biscuits developed in this study can serve as a vehicle for essential fatty acids, proteins, and fiber supplementation.

**4.2 Conclusion**

From the data obtained in the present investigation are sufficient to conclude that shatavari powder is an effective substitute for wheat flour in biscuits preparation. The biscuits prepared using shatavari powders were found to be acceptable in terms of quality characteristics. This substitution increased the protein content of the biscuit. The biscuits made with a 40% replacement of wheat flour with shatavari powder flour were the most acceptable. Therefore, it is concluded that the developed processing technology for making shatavari powder-incorporated biscuits is techno economically feasible. Biscuits with this formulation should be produced andmarketed on a large scale to provide nutritious and healthy food products to consumers.

**Competing interests disclaimer:**

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

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