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Review Article

A REVIEW ON BISCUIT, A LARGEST CONSUMED PROCESSED PRODUCT IN INDIA, ITS FORTIFICATION AND NUTRITIONAL IMPROVEMENT

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ABSTARCT

Biscuit is India's largest industry amongst food industries, with an estimated production of 70, 000 tonnes and cost of three thousand billions US Dollar. Biscuit along with bread forms major baked food accounting to over 30% and 50% respectively of total bakery products produced in the country. The industries have been established in organized and unorganized sectors contributing equal share. The bakery products produced in organized sector are well recognized as compared to organized sector products which are packed in sophisticated packaging. Biscuit is a diverse group bakery product ranging from varieties high and low in fat, high and low in sugar in more or less combination. Biscuits are available in wide varieties of shape, size, taste and texture. These varieties are coming from both organized and unorganized sector. However organized sector has very large capacity plants and their total number is few thousand. The number of units in unorganized sector is of order 80,000. Biscuits are fortified with wide variety of cereal like finger millet, gram flour, soy flour etc. Biscuit becomes an important source of high molecular carbohydrates, vegetable proteins and some vitamins and minerals. But it is important to know that, as compared to refined wheat flour which is deficient in certain essential amino acids thus requires a balanced nutritional value. The nutritional value of biscuit can be enhanced by fortification and supplementation with a wide variety of protein rich cereal and pulses. Some of the cereals are rich in dietary fibre and hence they can increase the nutritional value of the biscuit. Gram flour, Soya flour, Ragi flour and pearl millet flour the most efficient protein source of vegetable origin containing good quantity protein and dietary fibre, besides other nutrients like carbohydrate and reasonable quantity of minerals and vitamins.

Keywords: Biscuit, Organized sector, Quality, Capacity, Texture and Taste

INTRODUCTION

Biscuits constitute major component of human snacks in most part of the world. It is an unleavened crisp, sweet pastry made from wheat flour, shortening (hydrogenated fat) & sugar, and is usually made light by the addition of baking powder (a mixture of sodium carbonate, sodium bi-phosphate & cereal flour). Wheat flour constitutes the basic ingredient for biscuit production because of its gluten proteins, which are not present in flour of other cereals. Gluten protein forms elastic dough during baking and gives high organoleptic quality to the finished product.

Bakery industry is the one of the largest food industries in India with an annual turnover about Rs 3000 billion. The biscuit industry has been growing at an average rate of 15% during the past 3 years and this is expected to be maintaining in coming years (IBMA, 2010).

Biscuit consumption per capita in India is 2.1 kg, compared to more than 10 kg in the USA, UK and West European countries and above 4.25 kg in South-east Asian countries, e.g. Singapore, Hong Kong, Thailand, Indonesia, etc. China has per capita consumption of 1.90kg, while in the case of Japan it is estimated at 7.5kg (Serivastava, 2009).

The total production of biscuits in India is estimated to be around 30 Lakh Metric tonne, the organized sector accounts for 65% and the unorganized sector accounts for 35% of the total industry volume. The organized sector is valued at above Rs. 8000 crores. The export of biscuits is approximately 17% of the annual production, the export of sweet biscuits for year was Rs. 145.93 Crores and for year 2008-09 (April-Dec) was Rs. 280.00 Crores. The major exporting regions were Haiti, Angola, USA, Ghana, and UAE. The import of biscuit has not shown any significant growth during the last two years as compared to total consumption. The penetration of biscuits in urban and rural market is 85% and 55% respectively (Divya, 2011).

Year	Annual Production (Lakh Metric tonne)	Annual Growth
2003-04	11.00	15%
2004-05	12.54	14%
2005-06	14.29	14%
2006-07	16.14	13%
2007-08	17.14	15%
2008-09	19.50	17%

Table 1: Annual production of organized biscuit manufacturing industry and growth of biscuit industry in India.

Source: IBMA April-June, 2010

Biscuit Consumption (India):

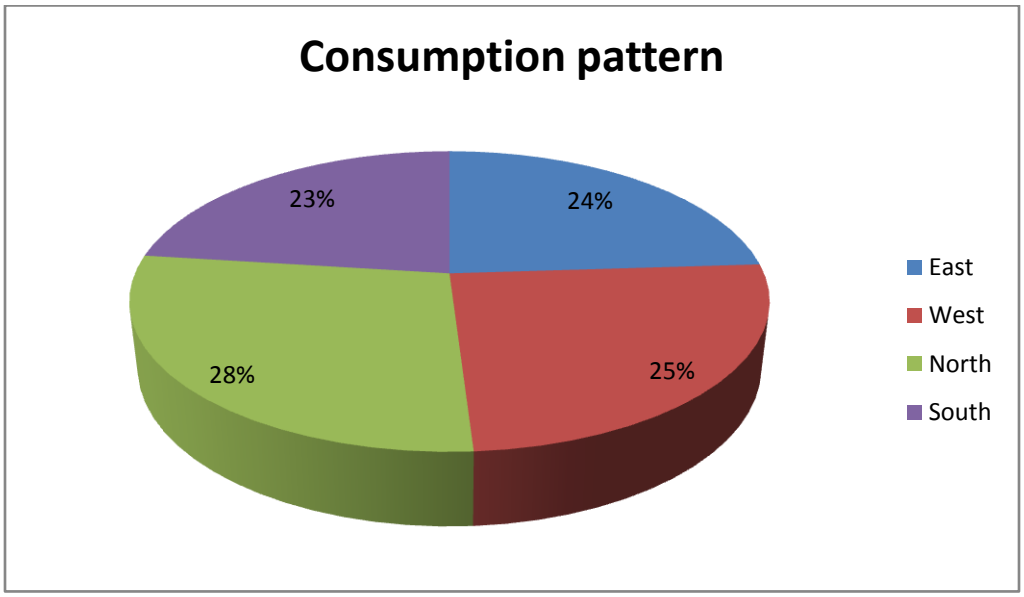

Figure 1: Consumption pattern of biscuit in India

(Source: www.marketsearchdata.org)

The biscuit category is divided into two segments, viz. popular and premium. The popular segment

with an annual growth rate of 6-7% includes glucose biscuits, milk products, marie etc. The specialty segment is growing at a rate of 20% per year. It includes cream, wafer cream, salt crackers, cookies and other varieties (Kaur*et al*., 2004).

Main categories of biscuits are broadly as under glucose, marie-sweet, cream, salty and milk. Glucose and Marie are two varieties of biscuits which represent the largest segments. Table gives the contribution of various biscuit segments as per the industry estimates (Baisya, 2007). Like any other consumer product, consumers have strong preference for branded products. Irrespective of income group in urban area the preference of purchase of branded Marie biscuits is of the tune of 80-90%. However, the rural market constitutes 53% of total sale mainly comprising of unbranded products (Agarwal, 1990).

S. No.	**Product Segment**	**Percent**
1.	Glucose	44
2.	Marie	13
3.	Cream	10
4.	Cracker	13
5.	Milk	12
6.	Others	8

Table 2: Various Products Segments in Biscuits

Sources :(foodbizdaily.com/Indian-biscuit-industry, Production data 2000-01)

The market in India is diverse and biscuit sector is divided into organized sector (40%) and unorganized sector (60%).

The branded and organized biscuit sector is forecast annual growth of 17%. Major players in this segment include Britania, Parlae, ITC, Priya Gold etc. Growth in the un-branded biscuit sector, which currently has a smaller market, is much smaller at 8% per year.

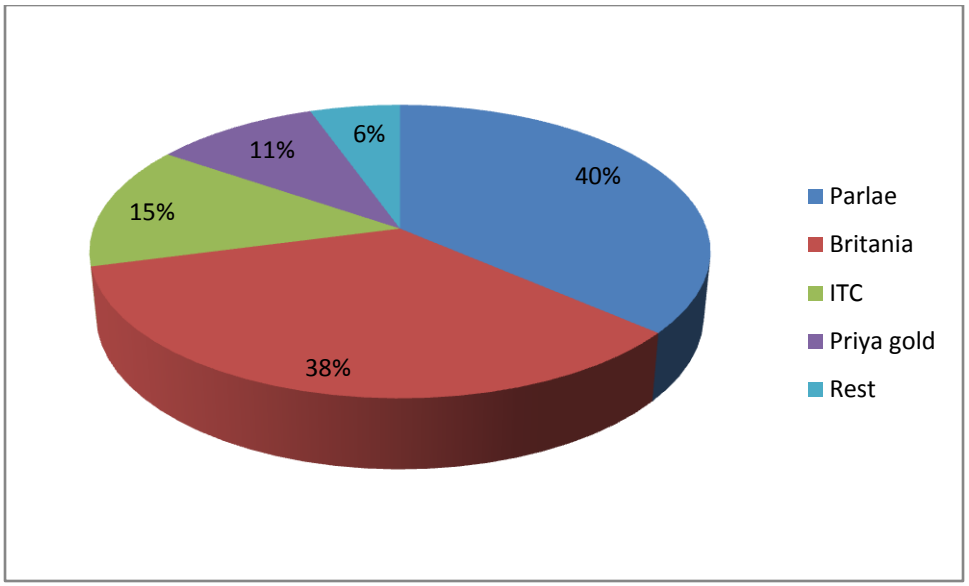

Figure 2: Market share of biscuit (Brands wise) in India

(Source: www.ibmabiscuits.in)

Protein malnutrition is a serious problem in India due to cereal based dietary pattern. Therefore, various preparation based on cereal-pulse combination are of paramount importance to improve the protein quality of Indian diet. The requirement of supplementary food is increased to reduce malnutrition. Supplementary foods should be such, if taken in small quantity, could provide necessary amount of nutrients. They should be made in form of ready to eat snacks, drinks etc.

Biscuit have been man's food since a long time. It is a processed convenience food ever produced and in most widely acceptable. It is one of the few universal staples, which is complete in it and requires no additional preparation. Thus, for many, Biscuit becomes an important source of high molecular carbohydrates, vegetable proteins and some vitamins and minerals. But it is important to know that, as compared to refined wheat flour which is deficient in certain essential amino acids thus has a lost nutritional value. The nutritional value of biscuit can be enhanced by fortification and supplementation with a wide variety of protein. Soya bean is the most efficient protein source of vegetable origin containing about 40% protein besides other nutrients like (carbohydrate about 22%), fat about (19.01%) and reasonable quantity of minerals and vitamins(Gandhi et. el, 1985).

DISCUSSION

The word Biscuit is derived from Latin word Biscoctum means twice baked. Biscuits are one of the low cost processed foods, which are most widely consumed. They, amongst many snack items, have certain advantages such as being cheaper than the conventional snack items, easy to use at home or even during

travel, easily being available in massive variety of shops, size, taste, packs and appeals to all age groups. Apart form the good taste these are foods with substantial energy having whole some and nutritious quality which are available at reasonable price. They have good shelf life at ambient temperature. Besides being a very palatable vehicle of nutrition and energy, these biscuits convey the goodness of flour, fat and sugar in most acceptable and economical term. They have good shelf lives at ambient temperatures. Besides being a very palatable vehicle of nutrition and energy, these biscuits convey the goodness of flour, fat and sugar in most acceptable and economical terms (Sharma *et al.*, 2003).

Ingredients of Biscuits:

Selection of suitable ingredients is an important step in manufacturing the food products. It is, therefore, necessary to have proper idea regarding ingredients, their function and uses. Biscuit ingredients can be classified as binding or tenderizing materials, depending on their expected effect on the finished product. It includes flour, water, milk solid, egg white, cocoa powder, sugar, shortenings, leaving agents, emulsifier, starch and salt etc. (Patel *et al*., 2003).

Flour:

Being the basic ingredient, flour requires the greatest attention for the quality testing. BIS (Bureau of Indian Standards) have made specification of different flour use in the preparation of bakery products. The BIS specification of wheat flour for making of bakery products is given in the Table-1. Since, the formation of gluten is an essential component of bread and biscuit making processes and wheat is the contributor of the protein necessary for its formation it follow that a significant factor, which determine final product quality, comes from the wheat via the flour from the mill. The ability to form gluten is almost unique to wheat. The level and quality of the gluten forming proteins depend heavily on the variety, agricultural practices and environmental effects.

Constituents	Flour used for		
	Biscuit	Cake	Bread
Moisture, % (Max)	13.00	13.00	13.00
Protein, % (Min, d.b)	9.00	9.00	11.00
Gluten % (Min, d.b)	7.50	7.50	8.00
Total ash% (Max, d.b)	0.50	0.50	0.50
Acid in sol. Ash% (Max, d.b)	0.05	0.05	0.05
Alcoholic Acidity% (Max)	0.10	0.10	0.10
Water absorption% (Min)	55.00	55.00	60.00
Sedimentation% (Min)	22.00	22.00	30.00

Table-2.1: BIS Specification of flour

Source: Patel et al. (2003)

The wheat grain is broadly made up of three components:

- The inner endosperm, comprising mainly starch and protein.
- The outer bran, comprising mainly protein and fibre.
- The germ, comprising protein, fibre, minerals and vitamins.

Whole meal flour consists of 100% of the wheat grain converted to flour while in the production of white flour the miller will seek to separate the endosperm from the bran and germ (Catterall, 1998). The protein content of wheat flour varies according to the wheat that is used by the millers and any adjustment they may make in the mill. In general, the higher the gluten content in the wheat the higher the protein content of the flour produced from it. The higher the protein content of flour, the better is its ability to trap carbon dioxide gas and the larger can be the biscuit volume (Chamberlain, 1984).

Bran does contain protein but this will not have the same functionally as the proteins which are present in the endosperm. The particle size of the bran fragment is important, with smaller size causing a greater reduction in bread volume than larger particles for the same quantity of bran. The germ and the bran are high in less-functional proteins and in addition, it contributes natural reducing agents, which weaken

dough system (Cauvain, 1987).

The grade colour figure (GCF) of flour is a measure of the amount of bran that is present in wheat flour. The higher the GCF the lower will be biscuit volume (Cauvain*et al.*, 1985), in part because of the dilution effect on the functional protein content. With higher value for GCF the crumb colour will be darker.

Lipoxygenase in wheat flour is affected by variety, maturity and environmental factor. Faubion*et al.*, (1981) found lipoxygenase catalyzes peroxidation of polyunsaturated fatty acid with a preference for linoleic acid. The oxidized lipids then react with flour pigments. Lipoxygenase exists in several forms, four of which are found in soybean, a particularly rich source of enzyme. Soybean lipoxygenase can acts on polyunsaturated fatty acid in triglycerides, whereas wheat lipoxygenase acts only on free fatty acid (Hosney, 1986). Enzymatically active soy flour frequently is used as a dough supplement for its oxidative effects in commercial bread making. Other enzymes that are present in small amounts in flour include phytase, polyphenol oxidase, peroxidase and catalase.

Water:

Water hydrates the gluten protein during mixing, gelatinizes starch during baking and serves a solvent for solutes and dispersion medium for the other ingredients. The greater the quality of gluten, the greater is the absorption. The salts in water affect the properties of dough. Hard water containing magnesium and calcium ions may have 'tightening effect' and soft water a 'loosening effect' on dough. The nature of water used in dough is more likely to be of consequence in commercial biscuits production than in non-commercial biscuits making.

Water, besides being component of every ingredient, is also directly added into the preparation of most of the products. In baking, water plays an important role in production by providing the necessary medium for the physical, chemical, biological and biochemical reaction that underlie the conversion of raw material in finished baked foods. In addition, it has decisive influence on the overall quality and palatability of the finished baked products. It leavens the products by converting itself into the vapour during baking. It also assists in the control of dough temperature (Patel *et al*., 2003).

Water is added at the mixing stage to nearly all biscuit recipes. It functions as a catalyst because it is almost totally removed during the subsequent baking process. Water hydrates ingredients like flour and, if conditions are right during subsequent mixing, hydrated wheat protein changes into a viscoelastic material known as gluten. This is very important in determining the nature of the dough, how the dough behaves in the forming processes and ultimately the structure in the bakes biscuit. Water also allows the solution of some ingredients such as sugar and, in the case of chemicals, permits reactions to take place in the dough (Manley, 1998).

Fats:

The main function of fat is incorporation of air during creaming. When fat entraps the air in the form of minute cells and bubbles the volume increases. The ability of fat to absorb air during mixing is called its creaming quality. Good creaming incorporates about 270% of air when creamed with granulated sugar (Patel et al., 2003). Fat has numerous functions in cookies. Fat act as a stabilizer, when particles of fat are spread in the dough makes it more stable. Fat also contributes to the organoleptic qualities of cookies such as flavor and aroma. The added fat will surround the gluten network formed in the dough. This will aid in the lubrication of gluten during sheeting. As a result, the soft and more extensible dough will be formed. Sathe*et al.*, (1981) and Gupta (1988) observed significant decrease in hardness of control and soy biscuits. This was apparently due to mellowing action of fat on protein, which increased the spread and reduced hardness, compactness of biscuits.

Singh *et al.*, (1997) standardized fat (20-35%) and sugar (28-43%) in soy biscuits and observed that with increasing level of fat, the thickness of biscuits decreased whereas diameter, weight spread ratio and percent spread factor of Product increased gradually irrespective of soy flour incorporation in formulation.

Sugar:

Sugar is essential component of biscuit. Sugar functions not only as a nutritive agent but also as a texture, colouring agent and means of controlling spread. Singh et al. (2000) standardized the level of sugar in soy fortified biscuits and found that with the increasing level of sugar up to 37% in formulation, attributes such as weight, diameter ratio and percent spread factor of biscuits increase whereas thickness and hardness of product decreased irrespective of soy flour incorporation. A significant increase in spread ratio of control and soy biscuits was observed ($P<0.01$) with the each increment of 3% sugar in formulation. Greater spread at higher level of sugar was attributed to melting of sugar crystal causing spread action (US wheat Associates, 1988). Higher level of sugar in a cookie recipe leads to shortness and tenderness, thereby reducing the hardness mainly due to its action in dispersing the flour gluten (US Wheat Associates, 1988). Sugar affects the rate of hydration of gluten proteins by competing with wheat protein for the water present. Bohn (1959) found the decreased rate of hydration with elevated level of sugar need not result in decreased extent of hydration if the mixing time is increased to permit maximum dough development. The contribution of sucrose to sweetness of bread is due to fructose produced through inversion rather than to the sucrose itself. Henry (1976) stated that all of sucrose in biscuit formula can be replaced by high fructose corn syrup (HFCS).

it wasfound that the addition of an optimum concentration of a carbohydrate hydrolyzing enzyme preparation such as barely, wheat is important in absence of added sugar. Although HFCS is colourless, the effect can be somewhat market in highly coloured cakes, such as devils food (Saussele,1976) and can be avoided use of leavening system that are sufficiently acidic to control carbonyl amine reactions (Volpe and

Meres, 1976). With HFCS at 50 and 100% replacement level, Koepsel*et al*. (1980) found high ratio white layer cakes.

Sugar is used principally as sweetening agent in the preparation of biscuits. In addition to the pure sugar, crude sugar (i.e. brown coloured sugar), corn syrup and honey are also used. Sugar being hygroscopic in nature, absorbs and retains the moisture. The products remains moistened for a longer time. It caramelizes when heated, which provides dark brown colour to the product (Patel et al., 2003).

Whole milk powder:

Whole milk powder is used in the biscuit manufacturing because of its extended shelf life and consistent quality as compared to fresh and other forms of milk. It is most important moistening agent. The crust colour and water retention power of biscuits are improved by the milk sugar, i.e. lactose. Milk powder contain casein as a principal protein, it also contain all the essential amino acids hence it improve the nutritional quality of the biscuits (Patel et al., 2003).

Salt:

The basic function of salt in biscuit is to contribute flavor. Salt also have inhibiting effect on the formation of gluten during mixing. Salt imparts taste and makes the products appetizing and palatable. It lowers the caramelization temperature of cake batter and biscuit dough and, thereby, improves the crust colour and bloom (Patel et al., 2003).

There is strong relationship between the levels of salt and yeast in a given recipe. Salt has a significant effect on the osmotic pressure of the yeast cell and can be used to control the rate of fermentation. The more salt we use in a given recipe the more yeast will be needed to achieve a given proof time (Williams and Pullen, 1998).

Emulsifiers:

Emulsifiers are natural or synthetic substances that promote the formation and improve the stability of emulsion, e.g., dispersion of fat droplets in aqueous solution of water droplets in a continuous lipid phase. In some cases, they can be used to improve wetting properties-change the surface active agents are widely employed in the baking industry for these purposes (Matz, 1986).

They are also referred to as surface active agents, crumb softeners to as surface active agents and dough conditioners. Lecithin, mono and diglycerides, polyhydric alcohol esters, diacetyl tartaric acid esters of fatty acids, acyl – lactylates, polysorbate 60 etc., are the approved emulsifiers (Sharma et al., 2003).

Lecithin, a mixture of phospholipids, is found widely distributed in nature but is commercially

performed as a contaminant in crude soybean oil at the present time .It exists performed as a contaminant in crude soya bean oil, and the commercial method of preparation involves precipitation from the oil and subsequent purification. It may also be further processed by bleaching, etc. Lecithin is the least expensive of the emulsifier. Mixed with adsorbent to improve dispensing and mixing at point of use, or standardized by blending with small amount of oil. Commercial grades of lecithin are classed according to total phosphatides, colour and fluidity. The concentration of phosphatides in commercial lecithin ranges between 54% and 72%. The product specifications usually report the concentration of phosphatides as percentage acetone insoluble. Color is stated as unbleached, single bleached and double bleached. The bleaching process tends to reduce the effectiveness of lecithin as a surface active material. The consistency will be plastic or fluid Lecithin can be dispersed in water to form hydrates, and similar responses occur with propylene glycol. Glycerineetc (Matz, 1986).

Quality test for biscuit flour and dough:

Flour test:

Routine laboratory analyses on flour include moisture, ash and nitrogen determination. AACC (1983) method is used for crude fat. The degree of flour granules affects other properties of flour and thus particle size distributions are frequently of interest. Most particle size distribution data however are obtained by sedimentation method based on particle that if particle sizes are alike in density, their rate of settling from a suspension varies with their diameter, the procedure for assessing rate of sedimentation and type sedimentation. AACC (1983) method is a centrifugal method. Several flour tests are based on the relation of hydration capacity to quality and quantity of gluten protein. In a sedimentation test of hydration capacity (AACC, 1983), a relatively small amount of flour is suspended in a dilute lactic acid-isopropanol solution: the suspension is allowed to stand in a graduated cylinder. The volume of sedimentation read after five minutes is indicative of hydrogen capacity. Amylolytic activity is studies also with amyloggraph of a similar instrument.

Rheological tests:

The Alveograph or Chopin extensiometer is an apparatus that measures dough extensibility and resistance to expansion. A thin sheet of dough is clamped between two metal plates, the upper plate having a circular hold through which the dough can expend while the lower plate is provided with an air valve leading to a small air chamber. Pressure in the chamber is increased at constant rate and pressure in the chamber is increased at constant rate and pressure is recorded. Temperature is maintained at 77^{o}F. The manometer record normally shows rapid initial rise in the pressure as the dough sheet resists expansion, than a decline is noticed as the thinning sheet lose strength and stretches, forming a bigger balloon. Ultimately bubble bursts

and graph shows a sudden complete loss of excess pressure. Volume of bubble indicates baking strength of flour (Matz, 1986). Extensiograph measure the resistance to stretching of a cylinder of flour-water dough. Dough samples may be measured at various intervals after mixing to show changes in extensibility with tie. In this way one can know a response of dough in the bakery and quality of final product. Force required to stretch the dough is automatically plotted against the distance if stretches, so that a curve is drawn (Kaur*et al.,* 2004).

Dough test:

The farinograph (AACC, 1983) is widely used instrument for dough test based on principle that the extent of water absorption by flour during mixing, the consistency of dough, the time required for the development of maximum dough stiffness and the resistance of mixed to breakdown all are related to flour quality.

Baking test:

Baking test is the final test to judge flour for quality for a particular end product. Flour test baking procedures are chosen in relation to the ultimate purpose for which flour is intended i.e. bread making, cake making, biscuit making. The test is the final criteria by which quality of bread, cake and biscuit flour are judged (Kaur*et al.*, 2004).

Baking involves three major changes to the dough piece in its transformation into a biscuit. These changes are: an increase in thickness (the development of an open internal structure); development of a reddish brown surface coloration (due, principally, to the Milliard reaction); and a significant reduction in moisture. All of these changes are accomplished by the supply of heat to dough piece. If the heat is not supplied at the optimum rate one or all of desired change will be different from that which is the target (Manley, 1998).

COMPOSITIONAL EFFECT ON QUALITY CHARACTERISTICS OF BISCUIT

added defatted soy flour at 5-15% level in wheat flour and studied the rheological characteristics of dough. The value of farinograph, amylograph, extensiograph showed that defatted soy flour could be added in wheat flour up to 15% without affecting its biscuits making properties.

Prabhavati*et al.* (1973) studies the effect of baking on protein quality of high protein biscuits made from wheat and groundnut flour supplemented with lysine rich flour such as soybean, wheat germ and pea. They found baking caused 13-35.3% loss in protein efficiency ratio (PER) in various type of biscuits. They developed high protein biscuits using wheat, groundnut and soybean flour in ratio of 55:20:25. The percentage of moisture, crude fibre, ash, protein (N × 6.25) and reducing sugar were found to be 7.5, 0.52,

3.25, 15.8 & 4.9 respectively. Calcium and phosphorous content of biscuit were 439 and 228g/100g, respectively. Calcium and phosphorous content ion baked and unbaked biscuit was 4.8 and 4.8g/100g protein, respectively. Whereas the available lysine in biscuit was 3.44g/100g.

Scientist evaluated the high protein cookies prepared by adding 33% defatted soy flour and 27% peanut butter. The proximate composition of protein was 1.5%, fat 22.4%, moisture 4.7%, ash 2.4%, fibres 1.5% and carbohydrates 54.21%. The calculated energy content of cookies was 48 kcal/100g. Addition of soy and peanut butter substantially improved the micronutrient except thiamines were 5.25 times higher than those in wheat flour. The Ca, P and Fe, content of cookies were 49.1, 1.82 and 2.76mg/100g, respectively.

Sathe*et al*. (1981) evaluated the physico-chemical properties of wheat flour and crackers made from it with different percentage of fat (40, 60, 70 and 80%). 60% percent incorporation of fat was found to yield good quality crackers. The chemical composition of wheat flour and crackers having 60% fat was as follows, moisture 7.6% and 3.25%, protein 10.0% and 17.48%, fat 10.0% and 32.4%, ash 0.44% and 1.10%, starch 70.04% and 48.7%, and reducing sugar 0.12% and 0.81%. The available lysine content of wheat flour and flour by soy flour (10-20%). The protein content increased from 8.47% to 10.55% as against 6.50% in control (without soy flour).

Nochera and chadwell (1992) prepared biscuits containing wheat, breadfruit flour, soy protein, whey and found that biscuits containing 10% breadfruit flour, soy protein were judged more acceptable in flavor, color and texture.

Patel and Rao (1996) in the study on biscuit baking properties of composite flours containing varying levels of 0, 5, 10, 15, 20 and 25% untreated, heat-treated and germinated black gram flour (BGF) separately indicated that the diameter and thickness of biscuits gradually reduced with increasing quantity of BGFs. The hardness values significantly increased on incorporation of 25% of all the three differently processed BGFs. The organoleptic studies inferred that 10% of untreated, 15% of heat-treated and 10% of germinated BGFs were optimum acceptable levels for fortification. Use of 35% sugar, 22.5% fat and 0.5% sodium stearoyal-2 lactylate improved significantly the biscuit baking quality. In general, biscuits made from composite flour-containing 15% heat treated BGF, and optimized biscuit formulation were better than those made from 10% of untreated or germinated BGFs.

Singh *et al*. (1996) studies the biscuit prepared from the Biscuit prepared from the blends containing varying proportions (0, 10, 20, 30, 40 and 50%) of defatted soy flour (DSF), using the traditional creamery method for diameter, thickness of soy-fortified biscuit increased, where as diameter, spread factor of biscuits decreased with the increasing level of DSFs. The sensory results showed that a maximum of 20% DSF can be incorporated to prepare acceptable quality biscuits.

Singh *et al*. (1997) evaluated soy-fortified the biscuit compared for the effects of various levels of fat

(20, 25, 30 and 35%) and sugar (28, 31, 34, 40 and 43%), using the traditional creaming method. With increasing levels of fat and sugar in the formulation, attributes such as weight, diameter spread ratio and percent spread factor of biscuits increased, whereas thickness and hardness of the product decreased irrespective of soy flour incorporation. The results of sensory evaluation revealed that the scores for texture and overall acceptability in control as well as in soy biscuits improved up to 30% fat level and thereafter decreased. However, the effect of increasing levels of sugar on the texture and overall acceptability scores increased up to 37% in control biscuits and thereafter decreased, whereas in soy biscuits improving effects were observed up to maximum level of sugar.

Awasthi and Yadav (1998) studied three types of biscuits viz., biscuits containing 15% de-fatted soy flour (DSF); 15% DSF with water channa whey (25:75) and 15% DSF with water skim milk (50:50). Control biscuits made from wheat flour, water and other ingredients were used for comparison. These biscuits were evaluated for their storage characteristics. The biscuits were packed in two different types of packaging material viz., high density polypropylene film (160 gauges) and laminate of cellophane (150 gauge) and stored under ambient conditions. The average minimum and maximum relative humidites were 62 ± 15.2 and 84.1 ± 9.9%, respectively. The biscuit sample packed in laminated packaging material stored well for 30 days, whereas those packed in polypropylene films could be kept for 45 days.

Onweluzo and lwezu (1998) evaluated biscuits prepared from different blends of wheat-soybean and cassava-soybean flours. The composition, physical characteristics and sensory qualities of the biscuits were compared with wheat flour biscuits prepared simultaneously. Cassava-soybean flour biscuits (1:1) had higher protein and calorific values than wheat flour biscuits. Wheat-soybean flour (1:1) biscuits had twice the protein value of the wheat flour biscuits and higher calorific value. The control wheat flour biscuits showed a higher spread ratio of 1.8 and lower break strength of 1.8 kg. The cassava-fermented soybean (1:1) biscuits showed comparable crispness as break strength (1.7kg) with the control, but had half the spread ratio of the control. The wheat-soybean biscuits (1:1) had low spread ratio (1:0) and high average break strength of 2.6 kg. Biscuits containing more than 50% fermented soybean flour showed low texture and flavor scores.

Singh et al. (1998) studied soy biscuits first standardized with baking powder (0.5, 0.8, 1.1 and 1.4%) and skim-milk powder (0.8, 1.6, 2.3 and 3.1%) levels, using the traditional creamery method. On the basis of good spread ratio and maximum overall acceptability score, baking powder at 0.8% level and skim milk powder (SMP) at 1.6% level were incorporated in the formulation of soy biscuits. Then optimum levels of sodium stearoyl-2-lactylate (SSL) (0.3 or 0.5%) and glycerol monostearate (GMS) (0.5, 0.75 or 1.0%) were incorporated in the formulation with three different levels of fat (20, 25 and 30%). They reported that the spread ratio and overall acceptability increased, where as hardness of the product decreased with increasing levels of SSL or GMS, irrespective of fat levels. Further, on basis of maximum spread ratio and acceptability scores, SSL and GMS in soy biscuits were standardized at 0.5% and 1.0% levels, respectively. It was observed

that both SSL and GMS could be used as shortening replacer in soy biscuits, since biscuits containing 25% fat with standardized levels of GMS and SSL had almost the same quality characteristics as those of biscuits containing 30% fat without emulsifiers.

Chauhan*et al.* (1998) developed and standardized the soy-fortified biscuits. Soy biscuits were first standardized with baking powder (0.5, 0.8, 1.1 and 1.4) and dried skim milk (0.8, 1.6, 2.3 and 3.1) using traditional creamery method. On the basis of good spread ratio and maximum overall acceptability score, baking powder at 0.8% and dried skim milk at (1.0%) level were incorporated in the formulation with three levels of fat-20%, 25% and 30%. The speared ratio and overall acceptability increased whereas hardness of product decreased with increasing level of SSL or GMS irrespective of fat level.

few workers evaluated the biscuits whereas wheat flour was partially substituted by fat free maize germ flour or soy fibre and found dietary fibre of biscuits varied from 8.2-24.9% and protein from 113-127%. Biscuits formulated with 20% maize germ flour gave the highest PER and acceptance to the consumer.

Awasthi and Yadav (2000) prepared three types of biscuits (1) 15% D.S.F. (2) 15% D.S.F. and 75: channa whey (3) 15% DSF and 50% skim milk and found that biscuits containing last two proportion had higher amount of protein than those DSF and control. Moisture, ash, crude fibre content of soy fortified biscuits with channa whey and skim milk were also higher than those of control as well as biscuits containing only D.S.F. (defatted soy-flour).

Singh et al. (2000) evaluated the wheat flour and soy-fortified biscuits prepared with standardized levels of ingredients and emulsifiers (SSL and/or GMS) for chemical composition, in vitro digestibility and PER. Addition of 20% defatted soy flour in the recipe increased the protein, ash, crude fibre, calcium, phosphorus, iron, sugar (reducing and non-reducing) and available calcium, phosphorus, iron, sugar (reducing and non-reducing) and available lysine contents of biscuits. No trypsin inhibitor activity was found in soy biscuits but had marginally higher non-enzymatic browning than the control samples. The in vitro digestibility values of control and soy biscuits were found to be 68.46% and 83.82% respectively. The PER of soy biscuits (1.41) had improved to a greater extent, which could be attributed to the higher levels of protein and available lysine content in defatted soy flour.

Gandhi *et al.* (2001) evaluated replacement of wheat flour up to 40% level with defatted soy flour in the standard sweet biscuits recipe, which increased the protein content from 6.02 to 14.8%, bending hardness from 3.60 to 9.80 N and cutting hardness from 6.02 to 23.04 N of the biscuits. Sensory evaluation showed that all of the biscuits from various blends were acceptable with no significant difference among them.

Selvaraj*et al.* (2002) studied on biscuits containing finger millet flour indicated that a moisture content of 5% equilibrating to 32% Rh was critical with respect to storage stability of the product. Shelf life

periods of biscuits were 75 and 50 days at 90% Rh, 38°C, when packed in double pack of polypropylene/pearlised BOPP and metalized polyester/poly laminate pack, respectively and over 120 days at 60% Rh, 27°C in both types of packs. Their sorption characteristics and shelf life were comparable to that of conventional glucose biscuits.

Prasad et al. (2004) evaluated the nutritional quality of biscuits enriched with spray dried egg powder, before and after storage for 6 month under ambient temperature (20-30°C). The food intake, weight gain of rats and PER of the biscuits enriched with spray dried egg powder were evaluated by rat feeding trails and compared with those from popular brand biscuits. Protein enrichment resulted in a 3-fold increase in the PER value compared to control. Egg although being an excellent source of protein, the PER value was not found to be at par with casein because of the fortification being done at low levels, to maintain acceptable sensory attributes. It is suggested that these biscuits can form a good substitute for eggs for armed personnel stationed in remote areas. Further, the product may find use as protein rich biscuits for infants and children.

CONCLUSION

Biscuit manufacture is no longer considered a craft but a full fledged technology, developed after a full understanding of the various processes involved with the help of basic principle of science and engineering. All over the world, manufacturing equipment has bee replaced by new and advanced automatic machines with high outputs. In some of the foreign countries biscuit manufacturing has been computerised. In India all branded biscuit like Britannia, Parley and Sun feast etc. manufacture is being heavily supported by their franchise units. There is ahuge demand of these biscuits. Irrespective of rural or urban area, it is the choice of consumer and hence the biscuit is the largest consumed processed product in India.

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