UNIT 14: PRODUCT DEVELOPMENT AND EVALUATION

Structure

14.1 INTRODUCTION

In India processed food is gaining importance as "commercial commodity". It becomes more evident when we see the wide range of packaged food products available in the market. Increase in popularity of processed foods can be traced to several causative factors: growing urbanization, changes in lifestyle, increasing number of nuclear families, working women and the purchasing power. Food industry in India is broadening its product range in response to emergence of wider clientele range. The industry has to cope with the competition from the multinational companies who are launching new products at regular intervals. In such a situation, the food manufacturers have to be watchful not only about maintaining and improving the quality of their products in the market but also about developing new products. These new products shall have advantages such as offering convenience, better nutritive value, health benefit, superior sensory quality and cost effectiveness. Developmental work in food industry is a continuous process beset with challenges. This unit will cover important areas of product development and evaluation.

Objectives

After studying this unit you will be able to:

- explain why is it necessary to develop new products
- describe what are the factors responsible for development of new products
- appreciate the role of sensory evaluation at different stages of product development
- assess consumer acceptability
- describe what are functional foods
- discuss the ingredients providing health benefits and their use in specialty foods and
- determine shelf life studies

14.2 NEED FOR PRODUCT DEVELOPMENT

In the present market scenario of processed foods we observe that sales profile of established brand names undergo unpredictable fluctuations. In a few instances, the once popular product may lose its premium position in the market. Therefore, the manufacturer should evolve effective strategies to achieve and to retain a well secured place in the market. One such strategy is to introduce new products having better consumer appeal. So now in this context, let us first understand what we mean by product development?

Product development is by definition a future-oriented practice. It is an effort to foresee the future needs of the market place and to translate this information into state-of-the-art products.

In order to develop a new product, the manufacturer should have the knowledge about all the factors influencing the development of new products. So then let us learn about these influencing factors.

14.2.1 Factors Influencing Product Development

Product development is an innovative activity designed to meet the changing consumer demands. It is becoming increasingly important in the dynamics of marketing environment. Product developers should be familiar with marketing, financial implications and logistics of introducing a new product into the competitive market. Moreover, they have to know how to undertake product development work from the customer's perspective. Products will have to be developed in response to a specific, clearly identified market opportunities. In addition to consumer demands, the driving forces behind new product development are peer competition, availability of new technology and alternate raw materials, and desire for novelty. Market fragmentation leads to developing different types of foods for various categories of consumers. As these are likely to intensify, the product life cycles are likely to shorten. Increase in the purchase power of sections of population, changing life styles, and increased emphasis on health and nutrition put pressure on processors to offer something new to the consumer. Science and technology in the food industry are increasingly defined by the demands and perception of the market place. To cope with such a situation the food industry has to resort to product development and innovation as a continuous activity.

But, whatever may be the influencing force, remember it is always important to develop consumer oriented products. And how do we go about it? Read and find out.

14.2.2 Consumer Oriented Product Development

It is important that new product development strategies are adjusted to identified needs in the market. This requires an appropriate methodology to translate consumers' choice or expectations into identifiable quality characteristics. Once this concept is formed it will be possible to provide detailed guidance for product development. Consumer oriented approach consists of five steps:

1. Identify the opportunity for new product

2. Design of the new product
3. Market testing of the new product
4. Launching the product in identified markets and
5. Life – cycle management.

Opportunity identification stage concerns the definition of the best market segment to introduce the new product, and the generation of new product ideas.

At the product design phase the plan of action is :

1. To identify the key benefits the product is to provide to the consumer
2. Positioning of these benefits versus competitive products and
3. Development of the product and marketing strategy.

Purchasing pattern of the consumer, what they consider important in their choice behaviour and what they consider short – comings in present product supply provide insight into some basic issues of product development. Consumer perception and preference have to be carefully studied while formulating a new product. Market testing may involve segmentation to identify relevant subgroups of consumers that are homogeneous in terms of preference and purchasing behaviour. If the new product is promising, as judged by the testing, it is ready for commercial sale.

With our understanding of the concept of product development and the factors which influence it, let us now learn the process i.e. the methodology of product development.

14.3 HOW TO DEVELOP A NEW PRODUCT

The process of developing a new product comprises three phases, namely formulation or recipe development, standardization of processing methods, and evaluation and testing of quality parameters of the final product.

The critical issues here are:

(i) to find out the optimised recipe,

(ii) to evolve effective processing conditions

(iii) to ensure food products of high quality and

(iv) to accurately predict marketability.

It is well known that most of the food products contain a variety of ingredients and preparing the product involves several processing steps. So, while working on a new product one has to study whether the recipes and methods of processing can yield an acceptable product, or is there a need for modifying them to improve the quality and to meet the demands of the market. The three phases of product development, you learnt about earlier, are interrelated and any changes that are made in implementation of one phase, will affect other two phases. Therefore, the task of planning the work becomes complicated. The simplest methodology, therefore, in product development is adopting *one – factor – at – a time method* which is also known as *trial and error method*. It is a simple method in which if changes are to be made in the formulation, only one of the ingredients can be changed at time. For example flavourings, salt, and sugar are the ingredients used in the preparation of sweet and spicy varieties of fried snacks. These are considered as the variables which influence the product quality. Affect of flavourings is tested by varying its level while maintaining constant salt and sugar levels. The product with optimal quality is selected. The optimal salt and sugar levels are then determined in a similar way. The optimal levels of flavourings, salt and sugar are then combined in the preparation of the sweet and spicy fried snack which will have the overall optimum quality. The trial and error method has been in use for along time. But this optimization method has certain disadvantages:

1. It is laborious and time consuming
2. It does not provide information about variable interaction effects, and
3. Achieved optimum consists only one variable levels that are actually tested. This could lead an inexperienced product developer to unreliable or false optimal results. In the above example, the change in salt and / or flavourings levels would probably modify the optimal salt level. Because of these possibilities the " overall optimum' achieved might not be the true optimum.

Considering these drawbacks, more effective methods have been introduced in the field of new product development, which are highlighted now.

14.3.1 Statistical Experimental Methods

Statistical experimental methods are used in product development. In order to adopt the statistical product design or experimental method, it is necessary to understand the basic concepts and terms. Important ones among these include:

1. *Independent variables* also known as factors are the parameters or characteristics, including ingredients and processing conditions, which have an effect on product quality. Independent variables can be varied. Amount or type of ingredients, temperature and time of processing and moisture content are examples of common factors in food production.
2. *Dependent variables*, or the responses are the important measurable food quality indices. These are influenced directly or indirectly by different factors. Some examples of responses are sensory quality, nutritional value, chemical composition, microbiological characteristics and shelf – life.
3. *Test levels* or levels are the quantity of factors selected to be tested in the experimental design. A combination of factor levels is chosen according the experimental design.
4. A *model* is a mathematical equation that describes the relationship between the response values and different factors quantitatively. It can predict optimized combination of factors to obtain products having required quality.

While dealing with the experimental design method, different kinds of system problems are encountered. These are discussed next.

A. Product process problem

In food product design, there are two different kinds of system problems – process and mixture problems – that should be dealt with by different statistical experimental methodologies.

In the process problem, all the independent variables are not related to each other but are *orthogonal* to each other. The change of one variable is not restricted by another variable. Geometrically, the lines representing these variables meet at right angles. In bread making for example, the temperature of the baking oven can, in principle, be chosen without any influence on the setting of baking time. Of course, only suitable settings of oven temperature and baking time can lead to desired bread baking results. To solve a process problem, the statistical experimental designs used should contain no or few correlations between the independent variables, so that their natural or original properties of "independence" can be retained. These kinds of statistical experimental designs are usually factorial experimental designs or designs derived from it.

B. Recipe problem

Recipe is one of the most important factors leading to successful food products. A recipe usually includes several ingredients, which have different effects on specific food quality. To study these effects is the prerequisite for being able to choose the optimal recipes.

Many food products are manufactured by mixing two or more ingredients. In bread and cake formulations, for example, flour, sugar, baking powder, shortening, and water are used. In this case, one or more properties of the food product generally depend only on the proportions of the ingredients present in the mixture and not on the amount of the mixture. One ingredient (an independent variable) cannot vary without changing at least one of the other ingredients in the mixture, because all the ingredients will be part of a constant sum of 100%. In other words, the variables or the ratios of different ingredients in the recipe are dependent on each other. These phenomena do not meet the orthogonality requirement of a conventional factorial design. Therefore, to study and model the effects that different ingredient components in a mixture have on the food product properties of interest, the factorial experimental design is no longer suitable unless it is modified. The effect of ingredient components (mixture variables) on food quality (response) are modeled differently from those effects based on the usual factorial experimental methodology.

As described above, the distinguishing feature of a mixture problem is that the independent or controllable factors represent proportionate amounts of the mixture rather than unrestrained amounts. These proportions are measured by volume, by weight, or by mole fraction. These are nonnegative numbers, and, if expressed as fractions of the mixture, they must add up to a unity, especially if the ingredients to be studied are the only ingredients comprising the mixture.

So you realize, how the process and the recipe, are important in development process. How do we get about with them? Let's get to know.

14.3.2 Modelling for process and recipe

Generally, all problems that appear in food product design can be divided into mixture or process problems, with the latter having the dominant share. Sometimes a problem that seems to be a mixture problem is really a process problem and can only be solved with a corresponding factorial experimental method. As explained above, the difference between a process and a mixture study is quite distinct, and these studies need different statistical experimental techniques to deal with. In practice, it is not easy to distinguish a process problem with a mixture problem, when the food product design is only concerned with recipe or formulation development. To get a better understanding of the difference between them, a short description of performing a factorial experiment for solving a process problem and of running a mixture experiment is given:

1. *A factorial experiment*: It studies the effect of some independent variables on food quality indices (response) through varying two or more of these independent variables, such as temperature, time, pressure and pH value. A series of values or test levels of each factor is selected, and certain combinations of their levels are tested.
2. *A mixture experiment*: An experiment in which the food quality indices (response) are assumed to depend only on the relative proportions of the ingredient components present in the mixture and not on the amount of the mixture. In such an experiment, if the total amount of the mixture is held constant, the value of the response changes when changes are made in the relative proportions of the ingredients.

The development of bakery powder is described as a practical example that will help you in understanding the difference between a factorial and a mixture experiment.

A premixed bakery powder for biscuit making consists of wheat flour *F* and three different chemical compounds *A, B* and *C*, which would be tested in the biscuit making according to a standard bakery experiment. The flour is used as a diluting medium, whereas A, B and C will be effective at different baking temperatures or baking phases. To develop an optimal baking powder formulation from F, A, B and C, the effect of various formulations are tested. Three different statistical experimental approaches are applied.

Strategy 1

Wheat flour F 3940 g is, mixed with 60g of A, B and C, yielding a ratio of chemicals to flour of 3:197 in all formulations. All mixtures are produced in total amount of 4000 g. In all tests, the amount of flour F in the baking powder is fixed, and the amounts of the three chemicals A, B and C are varied as indicated in Table 13.1.

Table 13.1: Mixture Experiment (Strategy 1)

Chemicals (g)				Flour (g)		Chemicals (%)				Flour (%)	Total	atio of Chemical: F
A	**B**	**C**	**Total**	**F**	**Total (g)**	**A**	**B**	**C**	**Total**	**F**	**(%)**	
40	10	10	60	3940	4000	1.00	0.25	0.25	1.5	98.5	100	3:197
30	15	15	60	3940	4000	0.75	0.375	0.375	1.5	98.5	100	3:197
30	20	10	60	3940	4000	0.75	0.50	0.25	1.5	98.5	100	3:197
20	20	20	60	3940	4000	0.50	0.50	0.50	1.5	98.5	100	3:197

Strategy 2

The wheat flour amount is fixed at 3940g, but that of the active ingredients is varied from 30 to 60 g with the ratio of A : B : C fixed at 3:2:1. The combinations to be tested are listed in the table 13.2.

Table 13.2: Mixture Experiment (Strategy 2)

Chemicals (g)				Flour (g)		Chemicals (%)				Flour (%)	Total	Ratio of Chemical: F
A	B	C	Total	F	Total (g)	A	B	C	Total	F	(%)	
30	20	10	60	3940	4000	0.750	0.500	0.250	1.500	98.500	100	0.0152
25	16.7	8.3	50	3940	3990	0.627	0.418	0.209	1.254	98.746	100	0.0127
20	13.3	6.7	40	3940	3980	0.502	0.335	0.167	1.004	98.996	100	0.0101
15	10	5	30	3940	3970	0.378	0.252	0.126	0.756	99.244	100	0.0076

It is a single-factor experiment with four test levels of baking powder. Actually only the ratio of chemicals to flour are changed in the study. In this way the effect of changing the chemicals: flour ratio or of changing the amount of chemicals while holding the amount of flour constant can be measured. In this experimental design the effect of ratio of the chemicals to flour would be examined. Note that if the percentages of A, B and C are varied in addition as in the first experiment, this would then constitute a flour-component, mixture-amount experiment.

Next look at the third strategy.

Strategy 3

Two levels of wheat flour 3960g and 3940g and two levels of baking powder 60g and 40g are selected to be tested. In all trials the percentages of A, B and C are fixed at 3:2:1. The formulations are as in Table 13.3. This is obviously a factorial experiment in which we are interested in measuring how the biscuit quality will be influenced by changing the level of flour and chemicals.

Table 13.3: Mixture Experiment (Strategy 3)

Chemicals (g)				Flour (g)		Chemicals (%)				Flour (%)	Total	Ratio of Chemical: F
A	B	C	Total	F	Total (g)	A	B	C	Total	F	(%)	
30	20	10	60	3940	4020	0.497	0.497	0.249	1.5	98.50	100	0.01523
30	20	10	60	3940	4000	0.500	0.500	0.250	1.5	98.50	100	0.01523
15	10	5	40	3960	4000	0.250	0.250	0.125	1.0	99.00	100	0.01010
15	10	5	40	3940	3980	0.254	0.254	0.127	1.0	99.00	100	0.01010

The example above gives a fair idea about how the factorial, mixture experiments are conducted for product development. With this we end the first section. Read the points to remember given herewith to recapitulated what you have learnt so far. Now attempt the check your progress exercises given herewith to judge for yourself how much you have grasped about the subject so far.

Points to remember

1. Product development is an innovative activity designed to meet the identified needs in the market.
2. Consumer perception and preference have to be studied while formulating a new product.
3. Product development comprises formulation, standardization of processing method and evaluation and testing of final product.
4. The simplest methodology in product development is the trial and error method.
5. Statistical methods of product development are Factorial experiment and mixture experiment.

Check your progress Exercise 1

1. Define product development

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2. List the factors influencing product development.

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3. What is trial and error method?

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4. What are Independent and dependent variables?

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5. What are factorial experiment studies?

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6. What is a mixture experiment?

The next crucial aspect of product development is sensory evaluation i.e. to evaluate the product on the basis of appearance, acceptability on part of the consumer or on information based on food acceptance data. These aspects are discussed within the next sub-section entitled sensory evaluation.

14.4 SENSORY EVALUATION

We begin our discussion on sensory evaluation by first understanding what we mean by sensory evaluation. *Sensory evaluation is a scientific discipline used to evoke, measure, analyse and interpret reactions to those characteristics of foods and material as they are perceived by the senses of sight,smell, taste, touch and hearing.* Next, why use sensory evaluation? Well, sensory evaluation is used to:

- evaluate a range of existing food products
- analyse a test kitchen sample for improvements
- gauge consumer response to a product
- check that the final product meets its original specifications

One may further wonder, why does the food industry need sensory assessment? Well, the food industry always try to :

- develop new products by modifying existing formulations
- enter new markets
- compete more effectively in existing market
- keep a high level of quality

These compulsions, therefore, make sensory evaluation very essential. Food quality, or from the *consumer view point*, food acceptance is the most critical aspect of food. The collection of *food acceptance data* is a key component in studies on product development, quality control, food product acceptance in the market place and food service evaluation. How is this data collected? What are the different processes involved in the assessment of the product being developed? Usually, a sensory panel is constituted to conduct periodic quality assessment of the product, followed by consumer testing. Let's learn about these processes.

A. Sensory panel

During the product development cycle it is necessary to conduct periodic quality assessment of the product being developed. This is done either with a consumer panel or a trained panel. Both kinds of panels are required as constituents of product development team. The trained panel is selected and trained in such a way that the panelists are capable of giving high reliability of judgments independent of psychological factors such as bias, motivation and individual experience. The expert is not viewed as representing the consumer. The role of the expert in product development is to determine flaws in the development process (too salty, poor texture etc), and possibly to attribute these flaws to specific processing steps, eg: burnt note attributable to overheating or higher processing temperature. This information is used by the developer to alter the formulation or to improve processing. As a result of experimentation and sensory evaluation an optimized product is developed. This is then submitted to a consumer to be maximally effective.

B. Consumer testing

Consumer testing is the next crucial aspect in product development. Consumer testing can be done in three ways:

1. in-house laboratory testing
2. home testing and
3. institutional testing

Let us discuss each of these next.

1. In-house laboratory acceptance testing represents the most controlled environment in which to conduct acceptance tests. Within the laboratory testing area, one can control a number of environmental variables (odour, light, temperature, humidity etc) and a number of stimulus variables (serving temperatures, portion size etc). In-house testing utilizes either laboratory personnel or consumers brought in for the tests.

2. In home testing, the selection and maintenance of a consumer panel is a key issue. The co-operation rate from consumer home panels is approximately 50 percent. It has been found that co-operation is best in households with:

a) more than two members
b) a younger housewife and
c) more education.

But home testing presents a practical problem, that is, the process of data collection is not done under the supervision of the investigator. Therefore, validity of the procedure and resulting data cannot be directly assessed.

3. The institutional food service setting, on the other hand, provides an excellent opportunity to collect food acceptance information. It is preferable to collect the food acceptance ratings from the consumers as they are eating, or just after they have completed eating. Collection of direct consumer acceptance ratings also provides the researcher with an opportunity to observe the food system in operation and to interact with consumers. Food acceptance data is collected by using feedback forms that are filled by the consumers. For their effective use the feed back forms should be brief and clear; it

should take only 1–2 min to fill out. Secondly, the format of questions should provide information which can be acted upon. Data collected on a number of food products showed that the card or form with different scales for different food attributes was most effective and useful. One example of a feed back form used in the consumer testing of low fat cake is given here.

FEED BACK FORM

After you have tested the ***Low Fat Cake***, please rate it for each of the following characteristics by checking one box in each category.

Temperature	Flavour	Portion Size	Texture
Too Hot ☐	Good Flavour ☐	Too Big ☐	Bad Texture ☐
Slightly Too Hot ☐	Slightly Good Flavour ☐	Slightly Too Big ☐	Slightly Bad Texture ☐
Just Right ☐	Neutral Flavour ☐	Just Right ☐	Neutral Texture ☐
Slightly Too Cold ☐	Slightly Bad Flavour ☐	Slightly Too Small ☐	Slightly Good Texture ☐
Too Cold ☐	Bad Flavour ☐	Too Small ☐	Good Texture ☐

Considering everything, how was the ***Low fat Cake***

Good ☐ Slightly Good ☐ Neutral ☐ Slightly Bad ☐ Bad ☐

COMMENTS

You would have made note of the fact that food acceptance data is collected by the consumers by using feedback forms. There are a few acceptance tests normally carried out to evaluate product acceptability. What are these tests and how they are conducted? How is the sensory evaluation carried out during the product life cycle? These are some other crucial aspect we should know while on the topic of sensory evaluation. Read the next sub section and find out.

14.4.1 Acceptance tests

What are *Acceptance Tests*? Acceptance tests are used to *evaluate product acceptability or liking or to determine which of a series of products is the most acceptable or the most preferred.* It should, however, be emphasized that acceptability and preference are not the same thing. For example, a person may prefer product A to product B, but actually find them both unacceptable.

Information derived from acceptance testing will only be of value if it reflects the results that would be obtained in the population at large, and this is unlikely to be achieved unless a panel which represents the target population is recruited. Such consumer panels are usually quite large, and their use in product testing has tended to be the responsibility of the market researcher rather than the sensory analyst. However, there are common features in the test methodology and common products being studied, so it is appropriate for the sensory analyst to be aware of the existence and purpose of these acceptability tests, if only in the interests of the effective interdepartmental communication. In addition, the sensory analyst can sometimes apply acceptance tests in a limited way to obtain an indication about product acceptability and may be asked to pilot such "consumer guidance" tests during product development and before products are subjected to more detailed market research.

There are three main methods of sample presentation that are used in acceptance tests – *monadic, sequential monadic and paired presentation*.

1. In *monadic tests*, samples are presented one at a time.
2. In s*equential monadic tests*, samples are presented in sequence, to be assessed one at a time.
3. In *paired tests*, samples are presented two at a time, generally with some form of direct comparison in mind.

What are the Types of Acceptance Tests?

There are two main aspects to acceptance testing:

- Measurement of Acceptability

- Comparison of acceptability or preference

These tests supply information about people's likes and dislikes of a product. Note, these tests do not intend to evaluate specific characteristics, such as crunchiness or smoothness. A discussion on these tests follows:

a. Hedonic Rating

In this test the assessor is asked to record the extent of liking for a product, usually by selecting a category on a "hedonic" or liking scale that runs from "extreme like" to "extreme dislike". A number of different scales have been developed and used.

A very popular scale is the following nine – point hedonic scale:

- Like extremely
- Like very much
- Like moderately
- Like slightly
- Neither like nor dislike
- Dislike slightly
- Dislike moderately
- Dislike very much
- Dislike extremely

The categories on this scale are equally spaced and it is quite common for the data to be analysed by assigning the values 1 to 9 to the categories on the scale, and then assuming that the intervals are equal. With this assumption, the data can be summarized by recording average liking "Scores".

b. Interval Scales

An alternative approach is to rate liking on a proper interval scale or on a continuous line – scale, with only the ends of the scale being labeled " extreme like" and " Extreme dislike'. The distance of the mark along the scale or line can then be used as a genuine score.

c. Ratio scales

It is also possible to record liking or acceptability using magnitude estimation scaling methods, but consumers may find it difficult to handle the concept of ratios without some initial practice, and may also feel uncomfortable with the arbitrary liking score that must be defined for the opening reference product.

d. Paired Comparison (Preference) Test

In this test the assessor is presented with two coded products and asked to indicate whether there is a preference between them. The test design should ensure that each sample is assessed equally often in first and second position.

The panel size should be at least 50. If the panel is drawn from staff on site, care should be taken to exclude people who may have particular knowledge of the nature of the work or knowledge of the objectives for carrying out the work. Bear in mind that such a panel is unlikely to be representative of the target consumer population.

At the simplest level the assessor is asked to state which sample is preferred and to offer reasons for preference. No – preference discussions are usually allowed and although, they are excluded from analysis, they are usually reported. This is a two – tailed test, as it is not known in advance which product is preferred, and both directions are of equal interest. The basic statistical analysis is by reference to two – tailed binomial tables, and the reasons for preference are tabulated.

Comparative assessments of acceptability or preference can be undertaken using the paired (preference) method or by the ranking test.

What Sort of Panel Is Required for Acceptance Tests?

Consumer panels are the best group to use for evaluating the acceptability of a product or a range of products because they can be recruited to a quota that matches the profile of the target consumer population in terms of product usage, demographics etc. when using consumers for such tests, there are relevant codes of practice and guidelines to be followed.

An *untrained panel* of at least 50 people, possibly drawn from an "in-house" panel of company employees may on occasion be asked to evaluate the acceptability of a product or a range of products. However, this panel will not normally be representative of the target consumers, so should only be used to provide an initial indication of acceptability or as a "consumer guidance" study. As always this panel should be drawn from people who have no particular knowledge of the nature of the work.

Under no circumstances should a *trained panel* be asked to evaluate the acceptability or preference of a product. Training encourages assessors to be diligent in focusing on objective measurement and generating information on the full range of product attributes. They can no longer be expected to behave as naïve consumers and provide simple subjective value judgments.

After a detail discussion of sensory tests and evaluation let us learn about the role of sensory evaluation during the product life cycle.

14.4.2 Sensory evaluation during product life cycle

The basic procedure for developing a new product, and supporting it while marketed, included distinct steps that are constant no matter what type of product is produced.

Initial screening in product development roughly defines the final product. The objective during this phase of life cycle is to formulate and physically prepare a prototype that is close to the final product, yet knowing the product will go through extensive optimization. The different stages during product life cycle are summarized herewith:

A. Product Optimization

Sensory analysis during this phase of product development is critical and includes extensive evaluation with many kinds of tests, each playing a specific role in optimization of the new product. Trained descriptive panels are used to characterize the flavour profile and other characteristics compared to what is already in the market. Consumer panel are used to determine product acceptability and aid in defining the formula and product specifications such as moisture, oil, salt, seasoning and oil flavour in fresh and aged products. Product testing by consumer panel can be conducted by the company developing the product or by an independent consumer evaluation agency.

B. Scale up

At this phase, sensory analysis consists of tests that compare the production samples with the optimized product. Depending on the resources available, either consumer panels or descriptive panels can qualify the production samples.

Sensory specifications are also determined before the product is taken into full production. This is a time consuming-process, similar to establishment of analytical specifications. The first step consists of screening of samples that represent reasonable extremes in the manufacturing process and also represent different raw material samples. Descriptive analysis is then used to characterize the products in quantitative terms. Consumer data are used to determine which attributes are critical and to set acceptable limits around the optimum target.

C. Production

Sensory analysis does not stop after the product has been developed and is being produced routinely. However, it is critical that products continue to be analyzed to ensure the finished goods are consistently manufactured to design criteria and that the product profile does not “drift” over time.

Typically, products and packages are inspected shortly after production in what is sometimes called a sample-cutting meeting. Persons involved in evaluating freshly made products must become familiar with how products with varying characteristics age during their expected shelf life. Traditional difference and / or variation testing should be conducted on a routine basis for quality assurance purposes. At this point, shelf-life testing should be conducted to ensure the product meets specifications till the end of its declared shelf life.

The entire discussion so far has been summed up in points to remember. Read them carefully**.** Next, answer the check your progress exercise to recapitulate what you have learnt so far**.**

Points to remember

1. During product development cycle it is necessary to conduct periodic quality assessment by employing sensory evaluation methods.
2. A trained sensory panel helps in development of the formulation and improving / modifying processing steps.
3. Consumer acceptance data is vital for studying the product quality and to predict acceptance in the market.
4. Hedonic rating is a well known acceptance test. Usually a nine point hedonic scale is used.
5. In paired comparison test the assessor is asked to indicate whether there is a preference between two samples.
6. Sensory evaluation during product life cycle consists of initial screening, product optimization, evaluation of product prepared during scale of studies and during regular production.

Check Your Progress Exercise 2

1. What is a trained sensory panel?

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2. Name the three ways in which consumer testing can be done.

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3. Why are acceptance tests used?

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4. Give the nine point hedonic scale.

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5. What is paired comparison test?

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6. Mention the stages in product life cycle, at which sensory evaluation is used.

So far we have learnt about the need for developing a product and the methodology of doing it. Now let us learn what are the ingredients that could be used in a product too make it a speciality product.

14.5 NEW PRODUCTS AND INGREDIENTS

Present day needs as well as future trends in food product development are taken into consideration in selecting the ingredients.

Increasingly the issue for the food industry becomes one of understanding the health benefits of food and diet and of targeting research towards elucidating the physiologically active components and their mechanisms of action. Many of these physiologically active compounds are found in well-known food sources, in addition to those less recognized. Soya, cereal bran, onion, garlic, many fruits and vegetables, are just a few among a wide variety of foods with potential health benefits. Research designed to understand and enhance these benefits is critically important. Clearly, such a targeted approach could lead to the development of "functional foods". What are these functional foods? The next sub-section focuses on this aspect.

14.5.1 Functional Foods

Traditionally, food products have been developed for taste, appearance and convenience for the consumer. With the increasing awareness of the role of diet in disease prevention there is an emergence of a new category of food products which provide health benefits. Generally, this type of foods, are called as *functional foods*. *These foods provide nutrition as well as certain health benefits*. A functional food is similar in appearance to conventional foods. It is consumed as part of a usual diet and has physiological benefits and / or reduces the risk of chronic disease. Functional food is also known as *" A food that has a component incorporated into it to give a specific medical or physiological benefit, other than a purely nutritional benefit"*. In other words these are the food products having a defined and well established health claim.

Health claim can relate to components of food or foods themselves. Three types of health claim are:

1. generic
2. commodity specific and
3. product specific.

Generic health claims are those that relate a nutrient of a food product to a particular disease or condition. One example of health claim permitted in USA is as follows: *"Diets low in saturated fat and cholesterol and rich in fruits, vegetables and grain products that contain some type of fibre, particularly soluble fibre, may reduce the risk of heart disease, a disease associated with many factors"*. On the basis of this statement, new products containing one or more of the above ingredients could be developed.

Commodity claim describes the claim for commodities or ingredients. Statements permitted in USA for oatmeal and oat bran reads: "*Diets high in oat bran / oatmeal and low in saturated fat and cholesterol may reduce the risk of heart disease"*. This highlights the health benefits of oat bran and meal. However, it does not indicate in the claim that the product on which the claim is placed is protective.

A product specific claim states that the product on which the claim is placed has a protective effect against a disease. For this type of claim, the product itself, rather than the ingredients or nutrients in it, have to be shown to have benefit. In all the above three types of claims, it is essential to provide scientific evidence in support of the beneficial effect of the commodity or ingredient or the product in the prevention or treatment of a condition.

From the above information, we have a fair idea about how to plan development of a functional food. In order to do this, we must know about the special ingredients required for the formulations. A few such ingredients are described here.

A. Oat products

Oats fulfill admirably the description of a functional food, as one that, in addition to providing all normal attributes of a food – basic sustenance, pleasing taste and texture – also confers a specific health benefit.

The outer layers of oats are similar to those of other cereals in being a good source of insoluble dietary fibre with the attendant capacity to improve colonic function and possibly reduce the risk of colon cancer. Many other functionally distinct components such as waxes, lignin, phytate, vitamins, minerals and phenolics concentrate in these layers. Some of these compounds are powerful antioxidants and may possess potent pharmacological properties. The Food and Drug Administration (FDA) of the USA has recently allowed a health claim for an association between consumption of diets high in oatmeal, oat bran, or oat flour and reduced risk of coronary heart disease. This represents the first health claim for a specific food under the Nutrition Labeling and Education Act (1990).The overall conclusion from the FDA review was that oats could indeed lower serum cholesterol levels, specifically low-density lipoprotein (LDL) cholesterol, without change in the high-density lipoprotein (HDL) fraction; on this basis a health claim for reduced heart disease risk was allowed. The FDA has allowed that the main active ingredient, in this respect, is the soluble fibre (1->3) (1->4)-β-D-glucan, or β-glucan.

B. Wheat bran

The useful role of wheat bran in promoting regularity in colonic function and preventing constipation is generally accepted. In addition, growing research has focused its protective effect against colon and breast cancers.

Amount of fibre in the diet has an effect on colonic function, the type of fibre and its digestibility or fermentability also play a significant role. Both soluble and insoluble fibres have value in promoting regularity in colonic function, as measured by stool weight and transit time, but they promote regularity via different mechanisms. Insoluble fibres, such as those from wheat bran, are resistant to fermentation by colonic bacteria and increase fecal bulk by retaining water.

Among the different sources of dietary fibre as fecal bulking agents, wheat bran is probably the most studied and among the most effective. Wheat bran ranked among the highest in fecal bulking, exceeding fibres from fruit and vegetables, gums and mucilages, cellulose, oats, corn, legumes and pectin.

From a food processing perspective, the range of particle size in commercially available wheat bran offers many functional benefits. While fiber particle size may affect its colonic effects, the range of particle size typically found in commercially available wheat bran (coarse bran > 1400 μm to very finely ground bran <500 μm) is well within that reported to be associated with fecal bulking effects.

C. Rice bran

Rice bran contains primarily insoluble fiber (cellulose) and soluble fiber (hemicellulose). Insoluble fiber adds bulk to the gastrointestinal (GI) track in humans causing more frequent stools that pass through the system more quickly, requiring less pressure to expel, and absorbing more bile acids thereby preventing their re-entry into circulation. This lowers the amount of bile absorption/reabsorption of dietary and or endogeneous lipid by the lower intestinal tract and promotes the synthesis of more bile acids from available cholesterol. Lowering serum cholesterol levels in the blood, specifically the low-density lipoprotein (LDL) fraction, aids in cardiovascular health and tends to lessen gallstone formation.

Rice bran is potentially valuable source of natural antioxidants such as tocopherols, tocotrieols, and oryzanols. Increased concern over the safety of synthetic antioxidants like butylated hydroxynisole (BHA) and butylated hydroxytoluene (BHT) has increased the interest in finding effective and economical antioxidants. Antioxidants extracted from rice bran potentially could satisfy this demand.

Defatted rice bran contains an increased percentage of fiber ranging from 35 – 48%, and can be used in speciality high – fiber products and baked goods. Rice bran fractions also possess emulsifying and foaming properties for baked products, meringues and whipped toppings. These fractions reportedly provide other benefits, such as leavening and texturization.

D. Soya bean products

Soya bean and its flours are used in the preparation of a variety of fermented and non-fermented products in Asian countries. However in India, food use of soya bean or soya flour is limited to a few extruded and texturised products. Soya proteins are known to reduce cholesterol levels in hypercholesterolemic individuals. The effect is greatest on those with the highest starting levels of cholesterol. These findings strongly support the inclusion of soya proteins (soya protein isolate and soya protein concentrate) in a wide variety of common food products. An average of 17-25 gms of soya protein per day was found to be effective in lowering serum cholesterol. Epidemiological and animal studies have indicated that there could be a correlation between consumption of soya proteins and certain chronic diseases like breast and prostrate cancer. In India food grade soya meal (defatted soya flour) is available which can be used in formulation of new foods having health benefits.

E. Grapes

The components of grapes and grape products believed to play a significant role in preventing or delaying the onset of diseases including cancer and cardiovascular diseases are the phenolic compounds. These compounds are secondary plant metabolites that contribute in an important manner to the flavour and colour characteristics of grapes, grape juices and wines. The phenolic compounds of grapes include phenolic acids, anthocyanins, flavonols, flavan-3-ols, and tannins. The flavonoids (C6-C3-C6), which include the anthocyanins, flavonols and flavan-3-ols, are powerful antioxidants, and are found in high concentration in grapes and grape products. These compounds exhibit a wide range of biochemical and pharmacological effects including antiinflamatory and antiallergic effects.

From the foregoing, it is evident that the grapes and grape products are rich in phenolic compounds, particularly flavonoids, which have demonstrated a wide range of biochemical and pharmacological effects, including anticarcinogenic, antiatherogenic, anti-inflamatory, antimicrobial, and antioxidant activities. The available information suggests that the regular consumption of currently available grape products should have a long-term health benefit. However, for increased concentration of grape phenolics, such as resveratrol, ellagic acid and flavonoids, new food products rich in these phytochemicals need to be developed. The byproducts of wine-making, grape skins, seeds and cluster stems are rich in catechins, proanthocyanidins and/or natural antioxidants, which can then be incorporated in the variety of foods such as breakfast cereals, bakery products and confectionaries.

F. Citrus Fruits

A large number of constituents in citrus products have been shown to be capable of preventing or alleviating diseases and promoting health. Vitamin C, E, and carotenoids, for instance, are thought to play a role in preventing or delaying the onset of major degenerative diseases of aging such as cancer, cardiovascular disease, and cataracts by counteracting oxidative processes. Similarly, several "non nutrient" components of citrus, including limonoids and flavonoids, appear to inhibit carcinogenesias by acting as blocking and / or suppressing agents.

G. Onion and Garlic

Onions (*A. cepa*), and garlic (*A. sativam*), have been used in traditional and folk medicine for over 4000 years. Disorders for which both garlic and onions have been used include asthma, arthritis, arteriosclerosis, chicken pox, the common cold, diabetes, malaria, tumors and heart problems. Modern science has shown that alliums and their constituents have several therapeutic effects, including *antiplatelet aggregation* activity, *fibriolytic activity,* anticarcinogenic effects, antimicrobial activity, and anti-inflamatory and anti-asthmatic effects.

Onion and garlic based products are currently marketed in a variety of forms. They include, for onions: dehydrated onion pieces, onion powder, onion flavourings, encapsulated flavours, oleoresins and essential oils, onion salt, pickled onions, canned, frozen and packaged onions; for garlic: dehydrated garlic powder, garlic salt, garlic juice, and garlic flavouring, encapsulated flavours, oleoresins and essential oils.

The processed products have considerable advantages to the food industry. The reduction in bulk means lower transport and distribution costs, the products are not subject to seasonal fluctuation in availability and prices, are more reproducible in organoleptic quality, and are more readily dispersed in food products than is the case with the chopped, sliced or blended fresh or stored vegetables.

The primary function of existing onion and garlic products is to provide consumers with the characteristic pungent flavour imparted by volatile sulfur compounds. In the past, value of both garlic and onion in disease prevention and health promotion, has been of little consideration in the development of consumer products from alliums. In recent years, their therapeutic properties have been recognized in the processing of onion and garlic capsules, tablets and even in the development of odorless products. These products, however, are more like drugs than true functional foods. Significant progress has been made in designing lower salt-, lower calorie-, lower cholesterol-, and higher fibre- and calcium containing foods, using new food ingredients, such as artificial sweeteners and carbohydrate or protein-based fat substitutes and new processing methods. Thus, one possible approach in development of novel-value-added allium-based functional foods involves incorporation of garlic and/or onion into food products such as bakery products, imitation meats and sausages, and meat pies. The key to the more widespread and increased consumption of onion and garlic and consequently to the increased exploitation of their medicinal and physiological properties, is improvement or elimination of the flavour of these vegetables.

G. Mustard

Although the primary use of mustard seeds is a condiments, important new food applications are regularly being found. Commercially available mustard products include mustard oil, mustard flour, ground and prepared mustards, and mustard bran. Mustard mucilage has *rheological* and *interfactial* properties that should find a wide range of applications in the food industries. Many of the components of mustard have beneficial physiological effects. These include isothiocyanates for possible effects on cancer prevention and antimicrobial activity; the viscous fibre and its effects on glucose and lipid metabolism; and the potential health benefits of phytates, dithiolthiones and proteins.

H. Marine lipids

Marine lipids originate from the liver of lean white fish such as cod, the body of oily fish such as mackerel, and the blubber of marine mammals such as seal. These oils consists of saturated, monounsaturated and polyunsaturated fatty acids (PUFA). There are two classes of PUFA, namely, the omega-3 and omega-6 families, which are differentiated from one another based on the location of the double bond from the terminal methyl group of the fatty acid molecule. Unlike saturated and monosaturated fatty acids, which can be synthesised by all mammals, including humans, the PUFA cannot be easily synthesized in the body and it must be provided through the diet. The omega-3 family of PUFA is descended from linolenic acid while its omega-6 counterparts are descended from linoleic acid. The unique feature that differentiates lipids of marine species from those of land animals is the presence of long-chain PUFA, namely, eicosapentaenoic acid (EPA; C20:5 ω3), docosahexaenoic acid (DHA; C22:6 ω3) and, to a lesser extent, docosapentaenoic acid (DPA; C22:5 ω3).

Consumption of marine oil results in a decrease in plasma lipids by reduced synthesis of fatty acids and low-density lipoproteins. It has also been suggested that marine oils may retard atherogenesis through their effect on platelet function, platelet-endothelial interactions and inflammatory response.

I. Sources of antioxidants

The primary biological role of antioxidant is in preventing the damage that reactive free radical can cause to cells and cellular compounds. In fact, almost all the food constituents having a protective effect against specific diseases seem to have some kind of antioxidant property. *Free radical is a group of atoms that behave like a unit,* eg.: Carbonate radical, ($CO_3^{- -}$), Nitrate radical (NO_3^-), and Methyl radical (CH_3^-). *Free radical contains one or more unpaired electrons.* Human body naturally produces free radicals as it metabolises oxygen. Reactive free radicals are able to produce metabolic disturbances and to damage membrane structures in a variety of ways. This may lead to cardiovascular disease, cancer and other health problems.

The current dietary recommendation to increase fruit and vegetable consumption is one which is widely perceived as health-promoting. Consistent epidemiological links worldwide between high fruit and high vegetable consumption and a greater life expectancy warrant more emphasis given to this particular dietary recommendation. Fruit and vegetables are the rich sources of the antioxidants, vitamin C, vitamin E, various carotenoids, flavonoids, isoflavones, organo-sulphur compounds, copper, manganese and magnesium and may also contribute to pools of endogenously produced antioxidants such as ubiquinol. Fruit and vegetables, however, are not the only dietary source of antioxidants and other rich sources of vitamin E include nuts and seeds, wholegrain breakfast cereals, wholemeal bread, eggs, margarine, vegetable oils, and dairy products.

A list of plant-based sources of antioxidants is presented herewith.

Plant-based Sources of Antioxidants

I. *Vitamin C (ascorbic acid)* – blackcurrants, green peppers, guava, gourds, greens, strawberries, kiwi fruits, citrus fruits, paw – paws, brussel sprouts, new potatoes

II. *Vitamin E* – sweet potatoes, spinach, broccoli, pulses, kale, tomatoes, asparagus, herbs

III. *Carotenes* – carrots, sweet potatoes, herbs, pumpkins, spinach, greens, kale, canloupes, chicory, squashes, red peppers, mangoes, apricots

IV. *Lycopene* – guaves, pink grapefruits, tomatoes

V. *Lutein and zeaxanthin* – kale, spinack, herbs, greens, celery, scallions, leeks

VI. *Flavonoids* – onions, strawberries, apples, citrus fruits, greens, broad beans, peanuts, grapes, tea

VII. *Isoflavones* – pulses, especially soya bean and linseed products.

VIII. *Organo-sulphur compounds* – allium vegetables; garlic, onions, chives, leeks

IX. *Ubiquinol* – beans, garlic, spinach

X. *Copper* – pulses, mushrooms, olives, gourds, avocados, lychees, blackberries, blackcurrants, kiwi fruits, grapes, mangoes, guaves, bananas, raspberries, plums, asparagus, potatoes

XI. *Manganese* – beetroot, blackberries, pineapples, pulses, spinach, greens, bananas, raspberries

Points to remember

1. Functional foods provide specified medical or physiological benefits.
2. Oats lower serum cholesterol level, specifically LDL cholesterol. Both soluble and insoluble fibres of wheat bran promote regularity in colonic function.
3. Rice bran ids a valuable source of natural antioxidants such as tocopherols, tocotrienols, and oryzanols.
4. Soya protein has the effect of reducing cholesterol levels.

5. Phenolic compounds of grapes play a significant role in preventing or delaying the onset of cancer and cardiovascular diseases.
6. Consumption of marine oil results in a decrease in plasma lipids.
7. Antioxidants prevent the damage that reactive free radicals can cause to cells and cellular compounds.
8. Several fruits and vegetables are rich sources of natural antioxidants.

Check your progress Exercise 3

1. Define functional food.

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2. Name the main active ingredient in oat products.

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3. Mention the role of insoluble fibres from wheat bran.

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4. Name the phenolic compounds of grapes and their significance.

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5. Name the types of food in which onion or garlic can be used for imparting health benefit.

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6. Consumption of marine oils results in:

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7. Name the health benefit of soya protein

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h) Name the plant based sources of the following antioxidants: Vitamin C, lycopene, isoflavones and organo sulphur compounds.

Our last discussion in this unit is on shelf life of products.

14.6 SHELF LIFE

Foods are perishable by nature. Numerous changes take place in foods during processing and storage. It is well known that conditions used to process and store foods may adversely influence the quality attributes in foods. Upto storage for a certain period, one or more quality attributes of a food may reach an undesirable state. At that instant, the food is considered unsuitable for consumption and it is said to have reached the end of its shelf life.

Shelf life of a food product may be actually defined *as the time between the production and packaging of the product and the point at which it becomes unacceptable under defined environmental conditions.* Storage and distribution are necessary links in the food chain, and hence considered as factors influencing the shelf life. We are all aware of the fact that food deteriorates with time and become unacceptable. In this context, it is useful to understand the factors that influence food deterioration. We will learn about these factors next.

14.6.1 Major modes of food deterioration

During storage and distribution, foods are exposed to a wide range of environmental conditions. Environmental factors such as temperature, humidity, oxygen and light can trigger several reaction mechanisms that may lead to food degradation. As a consequence of these mechanisms, food may be altered to such an extent that they are either rejected by the consumer, or they may become harmful to the person consuming them. Chemical, physical and microbiological changes are the leading causes of the food deterioration. A discussion on these changes follows.

Physical Changes

Physical changes are caused by mishandling of foods during harvesting, processing and distribution; these changes lead to reduced shelf life of foods.

Crushing of dried snack during distribution seriously affects their quality.

Dried foods when kept in high humidity may pickup moisture and become soggy.

Chemical Changes

During the processing and storage of foods, several chemical changes occur that involve the internal food components and the external environmental factors. These changes may cause food deterioration and reduce the shelf life. The most important chemical changes are associated with enzymic action, oxidative reactions, particularly lipid oxidation that alters the flavor of many lipid containing foods, and non-enzymic browning that causes changes in appearance.

Fruits upon cutting tend to brown rapidly at room temperature due to the reaction of phenolase with the cell constituents that are released upon cutting of the tissue in presence of oxygen. Enzymes such as lipoxygenase, if not denatured during the blanching process, can influence food quality even at sub-freezing temperatures. In addition to the temperature, other environmental factors such as oxygen, water and pH induce deleterious changes in foods that are catalyzed by enzymes.

The presence of oil and fats containing unsaturated fatty acids is a prime reason for the development of rancidity in foods during storage as long as oxygen is available. Development of off-flavours which is markedly noticeable in rancid foods is the result of autoxidation of unsaturated fatty acids. The generation of free radicals during the autocatalytic process leads to other undesirable reactions, for example, loss of vitamins, alteration of colour, and degradation of proteins. In addition to lipid oxidation, there are other chemical reactions that are induced by light such as loss of vitamins, and browning of meats.

Non-enzymic browning is a major cause of quality change and degradation of nutritional content in many foods. This type of browning reaction occurs due to the interaction between reducing sugars and amino acids. These reactions result in the loss of protein solubility, darkening of lightly coloured dry products and the development of bitter flavours. Environmental factors such as temperature, water activity and pH have an influence on non-enzymic browning.

Microbiological changes

Microbes have the ability to multiply at high rates when favourable conditions are present. Prior to harvest, fruits and vegetables have generally good defense mechanisms against microbial attacks, however, after separation from the plant they can easily succumb to microbial proliferation. Similarly, meat upon slaughter is unable to resist rapidly growing microbes.

Microbial growth in foods results in food spoilage with the development of undesirable sensory characteristics and in certain cases the food may become unsafe for consumption. The pathogenicity of certain microorganisms is a major safety concern in processing and handling of foods upon ingestion. Microorganisms such as *Salmonella* species and *Escherichia coli* strains cause infection while others such as *Aspergillus flavus, Clostridium botulinum* and *Staphylococcus aureus* produce chemicals in foods that are toxic to humans.

From our discussion above it is imperative that we develop mechanisms to determine, monitor and evaluate the shelf life of food products. How is this task done? Let's find out.

14.6.2 Evaluation of food quality

A common practice employed to evaluate the shelf life of a given food product is to determine changes in selected quality characteristics over a period of time. One may consider quality of a food as a gross measure of the food deterioration occurring in food item. However, it should be recognized that the term quality is meant to encompass several quality attributes or characteristics. From a consumer's standpoint, the sensory expectations derived from the presence (or absence) of desirable (or undesirable) characteristics of a given food determine the quality of a product. Therefore a food product noted for its high quality has more of the desirable characteristics.

Empirical or analytical techniques may be used to quantify the quality attributes of food. For example, enumeration of microbes or determination of chemical components of a product are analytical techniques, whereas the human subjects to monitor changes in the magnitudes of quality characteristics constitute empirical techniques.

14.6.3 Procedures for determination and monitoring of shelf life

Direct shelf life determination requires batches of samples to be taken at significant stages in the development or modification of the product. These samples should be examined during storage, usually under controlled environmental conditions, until their quality becomes unacceptable. *The time when this occurs is the maximum product shelf life*, and therefore the determination necessarily requires at least this time to complete.

Significant sampling stages within the programme of shelf life evaluation include:

1. The successful experimental kitchen or pilot plant batch. At this stage it is possible to investigate formulation, process or packaging changes to improve the shelf life without the costs of factory time and material quantities.
2. The successful full scale factory batch. This is the most important sampling stage. This will provide the data for the setting of shelf life and specification standards.
3. The first continuous production trial. Examination of products should confirm the data from earlier samplings.

As part of an on-going surveillance system, samples should be taken at suitable intervals for storage trial. The sampling interval should typically be 20% of the shelf life which will provide samples of 6 different ages from fresh to full shelf life. For long life products more frequent intervals may be useful to detect any changes in storage performance (e. g. every two months for a two year shelf life).

Shelf life samples should be subjected to conditions effectively simulating the normal storage and distribution conditions the food is likely to encounter.Shelf life examination is done by employing appropriate methods of: sensory evaluation; chemical analysis and microbiological analysis.

In sensory evaluation appearance, smell, texture and flavour being the main attributes to assess. Such assessments are frequently inexact as there may not be a suitable control sample with which to compare the stored samples, this being particularly so for new products. However, under appropriate test conditions using control sample it is possible to get a fair idea about the quality and acceptability of stored products.

Quantitative measurements, for example of colour, texture, viscosity and amount of water or oil separation should be included if they either closely relate to the sensory quality or can be used as reliable indicators of quality deterioration.

In addition to subjective assessments, other tests may be necessary. These may include tin content of products in unlacquered cans, vitamin content where a claim is made. Microbiological examination of fresh and stored products is highly essential in order to determine whether they are safe for human consumption.

Points to remember

1. Shelf life of a product is the time between the production and the point at which it becomes unacceptable.
2. Mode of distribution and environmental conditions of storage also influence the a shelf life of a product.
3. Chemical, physical and microbiological changes are the leading causes of food deterioration during storage.
4. Shelf life examination is done by employing methods of sensory evaluation, chemical analysis and microbiological analysis.

Check your progress Exercise 4

1. Define shelf life.

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2. List the major chemical changes occurring in food.

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3. Name the harmful microorganisms found in food.

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4. Mention the sampling stages of shelf life evaluation.

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5. Methods of shelf life examination are:

14.7 LET US SUM UP

In this unit, we studied about product development, which is an innovative activity designed to meet the demands of the market. There are various factors influencing the product development activity. As you learnt, the process of developing a new product comprises of formulation or recipe development, standardization of processing methods and evaluation and testing of quality parameters of the final product. While studying this process, you got to know that the simplest method in product development is known as one factor at a time, or trial and error method.

You also studied about the various problems that appear in food product design. These can be divided into two types- mixture problem and process problem. Further, we learnt that functional foods have physiological benefits and reduce the risk of chronic diseases. Some of the food ingredients of this category are oat products, wheat bran, rice bran, soya products, fruits onion and garlic, mustard and marine lipids. The types of health claims are: generic, commodity and product specific.

Finally, we learnt that shelf life of a food product is a crucial time. Other factors that affect the shelf life are mode of distribution and environmental conditions.

14.8 GLOSSARY

Acceptance test	**:** a method of evaluating product acceptability or liking by adopting a suitable sensory evaluation procedure.
Factorial experiment	**:** a design of experiment to study the effect of independent variables on food quality indices.
Hedonic rating	**:** a sensory evaluation method using a nine point scale that runs from like extremely -------neither like nor dislike ------dislike extremely.
Mixture experiment	**:** an experiment in which food quality indices are assumed to depend on ingredient components.
Shelf life	**:** time between the production and packaging of the product and the point at which it becomes unacceptable under defined environmental conditions.
Statistical experimental method	**:** product development activity carried out according to the statistically designed experimental method.

14.9 ANSWERS TO CHECK YOUR PROGRESS EXERCISES

Check Your Progress Exercise 1

1. Product development is a future oriented practice and an effort to foresee the future needs of the market place and to translate this information into new products.

2. The factors influencing product development are: growing urbanization, changes in life style, increasing number of small families and working women and the rise in power of purchasing consumers.

3. Trial and error method is the simplest methodology in product development. Only one ingredient in the formulation is changed at a time and its effect on the quality of the final product is tested.

4. Independent variables are the parameters such as ingredients and processing condition which have effect on product quality. Dependent variables also known as responses are the important measurable food quality indices.

5. Factorial experiment studies determine the effect of some independent variables on food quality indices through varying two or more independent variables.

6. Mixture experiment is an experiment in which food quality indices are assured to depend on the relative proportion of ingredients.

Check Your Progress Exercise 2

1. A sensory panel is the panel of members of which are capable of giving high reliability of judgements, independent of psychological factors such as bias, motivation and individual experience.

2. The three ways by which consumer testing can be done are: inhouse laboratory testing, home testing and institutional testing

3. Acceptance tests are used to evaluate product acceptability or liking or to determine which product is the most acceptable or the most preferred.

4. The nine point Hedonic scale is: Like extremely, like very much, like moderately, like slightly, neither like nor dislike, dislike slightly, dislike moderately, dislike very much and dislike extremely.

5. In paired comparison test, the assessor is presented with two products and asked to indicate whether there is a preference between them.

6. Initial screening, product optimization, scale up and production are the stages in product life cycle at which the sensory evaluation is used.

Check Your Progress Exercise 3

1. Functional food is a food that has a component incorporated into it to give a specific medical or physiological benefit, other than a purely nutritional benefit".

2. Soluble fibre and β-glucan are the main active ingredients in oat products.

3. The insoluble fibres from the wheat bran are resistant to fermentation by colonic bacteria and increase fecal bulk by retaining water.

4. Phenolic acid, anthocyanins, flavonols, flavon-3-ols and tannins are the phenolic compounds of grapes. They prevent or delay the onset of diseases including cancer and cardiovascular diseases.

5. Bakery products, imitation meats and sausages and meat pies are the types of foods in which onion or garlic can be used for imparting health benefit.

6. Consumption of marine oils result in decrease in plasma lipids by reduced synthesis of fatty acids and low density lipoproteins.

7. Soya protein reduces cholesterol levels in hypercholesterolemic individuals.

8. Vitamin C: Greens and citrus fruits
Lycopene: Guava and tomato
Isoflavones: Soya bean and linseed
Organo sulphur compounds: Onion and garlic

Check Your Progress Exercise 4

1. Shelf life is the time between the production and packaging of the product and the point at which it becomes unacceptable under defined environmental conditions.

2. The major chemical changes occurring in food are: lipid oxidation leading to rancidity, loss of vitamins and degradation of proteins; non-enzymic browning resulting in darkening of lightly coloured products; and development of bitter flavour and loss of protein solubility.

3. The harmful microorganisms found in food are *Salmonella* species, *E. coli*, *A. flavus*, *C. botulimum* and *S. aureus*

4. The sampling stages of shelf life evaluation are: Experimental kitchen or pilot plant batch, full scale factory batch and first continuous production trial.

5. Methods of shelf life examination are sensory evaluation, chemical analysis and microbiological analysis.