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Aims and Scope

International Journal of Food Engineering Research (IJFER) is an international , peer-reviewed journal devoted to the publication of high quality original studies and reviews concerning a broad and comprehensive view of fundamental and applied research in food science&technology and their related subjects as nutrition, agriculture, food safety, food originated diseases and economic aspects.

IJFER is an international periodical published twice a year (April and October). The journal is published in both print and electronic format.

From The Editor

Istanbul Aydın University Faculty of Engineering has started to publish an international journal on Food Engineering, denoted as "International Journal of Food Engineering Research (IJFER)". We have especially selected the scientific areas which will cover future prospective food engineering titles such as Food Processing, Food Preservation, Novel Technologies, Food Safety, Food Quality etc. and their related subjects as nutrition, food and health, agriculture, economic aspects and sustainability in food production.

We have selected only a few of the manuscripts to be published after a peer review process on many submitted studies. Editorial members aim to establish an international journal IJFER, which will be welcomed by Engineering Index (EI) and Science Citation Index (SCI) in short period of time.

Editor in Chief
Prof. Dr. Güner ARKUN

International Journal of Food Engineering Research (IJFER)

CONTENTS

COMPARISON OF FOOD SAFETY MANAGEMENT SYSTEMS

Ayşe AYTEKİN[1,*] Güner ARKUN[1]

Abstract

Today, conscientious societies demand the food products to be healthy in terms of production processes and ingredients, while at the same time demanding access to all sorts of information regarding them. The companies respond to this call by certifying their products regarding food safety through various certifications.

Since the purpose of this study is to compare the Food Safety Management Systems commonly applied in food production plants, the standards of the systems ISO 22000:2005, BRC version 7 and IFS version 6 are used as the main references of this study. A total of 13 topics thought to be critical regarding food safety are found to be fit for comparison. In addition, the issues of the transition of HACCP to ISO 22000 and the points at which the two standards differ have been dealt with and the enlightenment of the food sector on these issues is aimed in this study by emphasizing that the ISO 22000 and HACCP have to be thought as two different standards.

As a result of the comparison of BRC, IFS and ISO 22000 systems, it is found that ISO 2200 treats topics in a more general manner, and not include many topics that are treated in BRC and IFS. These topics are: control and detection of foreign substances, customer complaints, product analysis and finally audit protocols. The issue of audits is the most significant among the issues that are not included. It is seen that BRC and IFSs have given a section about the scope and the application of audits and that BRC has given a more detailed treatment of the issue of audits than the IFS, marking the audit, the requirement of which will be applied, according to its way of procedure.

Keywords: *Food Safety, ISO 22000, HACCP, BRC, IFS*

Introduction

Food comes first among the many other important needs in human everyday life. Safety and quality are some of the important criterias that every food must have. In addition, food should be accessible in terms of food security. Food reliability is described as "accessibility of people to food that is sufficient in amount, safe and high in nutritional value in order to sustain their healthy and active lives" [1]. On the other hand, food safety is to prevent/remove chemical, physical and microbiological dangers that have the potential to harm human health. There have been many organizations founded in the world about food safety and security. Aside from sustaining food safety, these organizations raise consciousness all around the world about providing nutrition and food to downtrodden people in under-developed, economically damaged or war-torn regions, and take necessary measures to help people who are in need.

In countries where there is no problem with food accessibility and where production and consumption are at normal standards, the most significant issues are the food safety and hygiene. Aside from its relevance for public health, food safety has also been an issue of market competition for food businesses.

Conscientious societies are demanding the food products to be healthy in terms of production processes and ingredients, while at the same

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time demanding access to all sorts of information regarding them. The companies respond to this call by certifying their products regarding food safety and hygiene through various certifications.

In today's world, the demand for food has increased proportional to the population growth. This increase in demand may weaken the care that is given by the producer to food safety on the production line. In the process that begins in the field and ends on the table, the human health has been disregarded and food has been produced in unnatural methods in order to gain boosts in production quantities. In order to increase the yield in food production chain, some misapplications are done by paying no attention to human health, i.e. using GMO (Genetically Modified Organisms) seeds, occurance of contaminants, using non regulated food additives etc. However, as they are increasing the quantity of the yield, extending the shelf-life of the goods and enriching foods in terms of flavor and texture, such applications are being regulated with certain limits and standards. Furthermore, issues such as the hygiene, quality, marketing and storage conditions in food plants, which are relevant and which must be a part of the whole discussion of food safety, are addressed in these standards.

In these standards, all the factors that come into physical contact with the food—the principle raw material or the ancillary material—throughout the food chain from the field to the table are taken under controll with systematic approaches. There exist penal procedures in case firms do not abide by the rules or get involved in any form of cheating or adulteration.

In order to maintain food safety, "Food Safety Management Systems" are formed. These systems are brought together under one roof by International Standards Organization (ISO) and all the standards proper for each institution are issued under distinct branches [1]. In addition to ISO, countries are forming their own standards to standardize imported goods, establish the fairness of the competitive environment between the producers and the retailers and protect the health of the consumers. Two of the best examples for such standards are IFC and BRC, which are created by German and British retailers, respectively.

In this study, it is aimed to compare the food safety systems ISO 22000, IFS and BRC, which are currently widely used, in order to help companies which want to employ these standards in their decision-making processes.

1. Food Safety Management Systems

Today, significant developments took place as the costumers become more conscious and the countries update their food-related laws in the direction of producing healthier and safer products, which made the issue of food safety one of the most important issues of the last few years. World Health Organization (WHO) and Food Agriculture Organization (FAO) *Codex Alimentarius* Specialists Commission defines food safety as, "abiding by the required rules and taking precautions during the processes of food production, processing, conservation, transportation and distribution, in order to maintain a healthy and perfect food production" [2].

Food safety consists of consumer consciousness and, regulatory rules composed by the state and the totality of methods and procedures employed by the producers and marketers. First and foremost, these three factors must fulfill their responsibilities [3]. The problems which countries all around the world face, emerge when one of these three factors is not properly addressed. Firstly, the consumer must assess the food he or she consumes and should demand the safe product; then, producers and companies must concentrate on this topic in response to the demand, learn about their responsibilities through the state regulations and standards, and implement them. Finally, producers and companies must be subjected to audits and penal sanctions by the state if needed.

With law no. 132, dated 18.11.1960, Turkish Standards Institution (TSE) was created and has been authorized to prepare standards in Turkey. TSE prepares standards and does licensing

regarding Food Safety Management System (GGYS), and Quality Management System (KYS) regarding the raw material, goods and services of all sorts of industries. All types of firms and service industries in our country have to conduct its operations in accordance with GGYS and KYS standards. Issues such as customer satisfaction and conformity with European Union on foreign trade require all firms to abide by the standards that apply to them [4].

The GGYS that this study is based are:

- ISO 22000:2005 (HACCP)
- BRC (British Retail Consortium)
- IFS (International Food Standard)

Among these, the one with the most wide-spread use is ISO 22000 Food Safety Management System. Sole employment of local standards of a country by its companies may cause problems of disconformity in foreign trade when these standards contradict with the local standards of another country. ISO 22000 is prepared as an international standard to prevent such problems [4].

Standards compared in this study are ISO 22000, BRC and IFS. ISO 22000 and HACCP is as taken as constituting one entity and the points of divergence are scrutinized.

1.1 ISO 22000:2005 and HACCP

ISO 22000 is a standard published in September 2005 and is issued in Turkey in April 24, 2006. Its logo is given in Picture 1. With this standard, the implementation of a food safety management standard with the tracking both of the pre-condition program and of the Critical Control Points, that is, the application of HACCP (Hazard Analysis and Critical Control Points), have been merged for the first time [5].

Picture 1. ISO 22000 logo

HACCP system is aimed at pre-detecting possible safety risks that may come out during the production process and taking the necessary precautions. These risks may be biological, physical or chemical. The system is proactive in its approach in that it is an application not of problem-solving but of problem-avoidance [6]. It was first published in Codex Alimentarius and made its way into the literature for the first time when it was used in producing high-safety food for NASA astronauts between the years 1972-73. Many countries published their own HACCP programs since 1990 [4]. The 7 principles of HACCP and 12 principles of Codex Alimentarius are as follows:

1) Formation of a food safety team

2) Product description

3) Product's usage as intended in its design

4) Formation of product-flow diagrams

5) Confirmation of flow-diagrams

6) Detection of hazards –*HACCP 1. Principle*

7) Detection of critical control points –*HACCP 2. Principle*

8) Determination critical limits for CCPs –*HACCP* 3. *Principle*

9) Formation of monitoring systems for CCP – *HACCP 4. Principle*

10) Planning of the corrective actions –*HACCP 5. Principle*

11) Confirmation –*HACCP 6. Principle*

12) Documentation and registration –*HACCP 7. Principle*

There are many standards that include these seven principles of HACCP. They made their way into the standards of EU countries in 1993 (e.g. The Netherlands and Denmark's HACCP, UK's BRC, Germany and France's IFS). In Turkey the TS 13001 standards published in March 3, 2003 included the seven principles of HACCP. With the publication of ISO 22000, this standard was annulled and HACCP took its new shape in our standard [4].

ISO 22000 consists of 8 articles. These articles, each of which has its own sub-articles, are as follows:

Article 1 – Scope

Article 2 – Standards and documents cited

Article 3 – Terms and descriptions

Article 4 – Food safety management system

Article 5 – Responsibilities of the administration

Article 6 – Resource management

Article 7 – Planning and realization of safe product

Article 8 – Acceptance, verification and rectification of food safety administration system [7].

1.2 British Retail Consortium (BRC)

BRC, which stands for British Retailer Consortium, is a standard prepared by the British retailers. It was published in November 1988. Under the title of BRC-Global Food, it standardizes the qualities that must be present in food, consumer products and packaging materials. BRC customer products contain the necessary responsibilities needed for obtaining technical proficiency regarding the special products. This standard can be applied both generally and specific to a product. BRC logos are shown in Picture 2 below [3].

Picture 2. BRC's logos

BRC was revised in January 2015 and this updated 7th Version took its place among other standards. BRC standard consists of 4 principle chapters. Chapter 2 titled "Requirements" consists of 7 articles, each of which are made of further sub-articles. The content of the standard in general is as follows:

Chapter 1: Food Safety Management System

Chapter 2: Requirements

Article 1: Responsibilities of Senior Management

Article 2: Food Safety Plan

Article 3: Food Safety and Quality Administration System

Article 4: Business Standards

Article 5: Product Control

Article 6: Process Control

Article 7: Personnel

Chapter 3: Audit Protocol

Chapter 4: Management and the Supervision of the Program

BRC standard refers to requirements that are critical as fundamental requirements. 3 types of nonconformities are depicted;

Critical: Deficiency in conformity to food safety and legal requirements.

Major: The situation in which there is a serious nonconformity between substance and the product.

Minor: The situation in which the requirements regarding a substance are not completely fulfilled but its conformity is proved through objective evidence [8].

1.3 International Featured Standards (IFS)

IFS food quality and food safety standard was prepared by the German Retailers Federation HDS (Handelsverband Deutschland) together with its French counterpart FCD (Federation des Entreprises du Commerce et de la Distribution). It is currently managed by IFS Management GmbH. IFS logo is given in Picture 3 below. The purpose of the standards is to provide the suppliers with a uniform quality and food safety system [9].

Picture 3. IFS Food logo

Other aims of IFS Food and IFS are as follows:

•Creating a standard in which the assessments are uniform,

•Working with licensing institutions approved and accredited by IFS,

•Creating a supplier ecology that is comparable and transparent,

•Saving time and resource for retailers and suppliers [9].

While version 6 of IFS, published in 2012, consisted of 4 chapters, the 2014 revision added a fifth chapter despite keeping the version number. Accordingly, IFS consists of 5 chapters. Chapter 2 entitled "Requirements" is made up of 6 articles, each of which has sub-articles of their own. The content of the standards in general is as follows:

Chapter 1: Audit Protocol

Chapter 2: Requirements

Article 1 – Senior Management Responsibility

Article 2 – Quality and Food Safety Management System

Article 3 – Resource Management

Article 4 – Planning and Production Process

Article 5 – Measurement, Analysis and Improvements

Article 6 – Food Defense and External Inspections

Chapter 3: Accreditation Institutes, Licensing Firms and Requirements for Audits

Chapter 4: Reporting, auditXpress™ Software and IFS Audit Portal

Chapter 5: IFS Food version 6 audit protocol for unannounced audits.

In IFS, the requirements that are considered critical are referred to as "Knock Out" (KO) requirements. If a nonconformity is seen regarding a KO requirement during the licensing procedure, 50% of the total points of a firm is taken away. The licensing cannot be put through. The nonconformities that fall out of the scope of KO requirements are named "major nonconformity." A major nonconformity reduces the total points by 15 %, and similarly the licensing cannot be carried out [9].

2. MATERIAL AND METHODS

Since the purpose of this study is to compare the Food Safety Management Systems commonly applied in food production plants, the standards of the said systems (ISO 22000:2005, BRC version 7 and IFS version 6) are used as the main materials of this study. In this direction, a copy of ISO 22000:2005 was obtained from TSE firstly and it is transmitted in the study in a plain manner as much as possible. Then, BRC version 7 and IFS version 6 was downloaded from their websites and are added to the study accordingly. A total of 13 topics thought to be critical for food safety and the implementation of systems are found to be fit for comparison. These are given in the section "Findings" in chart form and their differences are specified.

3. RESULTS

3.1 ISO 22000 and HACCP Comparison

ISO 22000 and HACCP cannot be assessed as two different standards. Aside from being inclusive of HACCP, ISO 22000 is a standard equipped with new details in terms of company application. That is, ISO 22000 is a whole that includes and complements the HACCP system. When a comparison is made, one can only speak of the advantages of ISO 22000 over HACCP system, not the differences of the latter from the former. ISO 22000 has taken the place of HACCP all around the world, but there still are firms who haven't made systems change.

One of the most significant common points of the two systems is the prerequisite program (PP) that both of the systems require, as shown in Figure 1 below. PP is the fundamental duty of a company that helps it to form a secure grounding before the establishment of the food safety system.

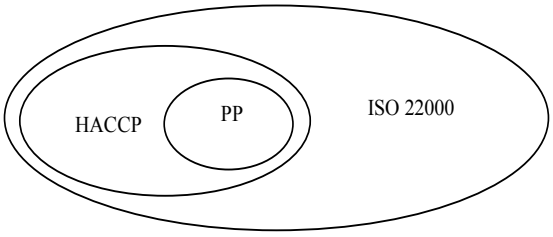

Figure 1. The Relation Between ISO 22000, HACCP and PP [4].

HACCP's limited concern over the production process is seen as a flaw in its way to becoming an international standard and this limited nature is taken as first step for the creation of ISO 22000. With its emphasis for the human factor, ISO 22000 manifests its difference by detailing such important issues not only of the hygiene of the personnel but also of the duties of the management, of the inclusion of the personnel into the system, of communication and many more. If examined closely, we can enumerate such ISO 22000 advantages as:

1) The most important advantage of ISO 22000 is that it has an international acceptance.

2) While the segment of HACCP user tend to be food producers, ISO 22000 has become a system that has been employed by producers who produce products that come in touch with food and by any types of institution that effects food (e.g. producers of animal feed, packaging and food equipment producers, cleaning products producers, institutions that provide storage and transportation services) [5].

3) Decent production practices receive mention in ISO 22000.

4) When a firm possessing a HACCP will also need ISO 9001,while ISO 22000 can be sufficient by itself. Only with an ISO 9001 does the company come into conformity with the system [10]. For this reason, the array of ISO 9001 and ISO 22000 articles are matched for the purposes of convenience.

5) Allergens control issue is among ISO 22000's requirements. This issue is not explicitly demanded in HACCP.

6) ISO 22000 emphasizes that a company's food safety goals and their process management be clearly explained. In HACCP, there is no mention of companies' food safety goals.

7) External communication is required in ISO 22000. It is demanded that in the process which starts with the raw material and ends in the final good, agents such as suppliers, storage and distributor companies be contacted, and that these agents are kept in touch for the purposes of food safety. This situation, which gathers all the monitoring activity in one locus, is very important for information flow. ISO 22000, which demands the detailed description and close examination of the input and the final product, touches upon many issues relating to external communications.

8) ISO 22000 allows for the instalment, updating and confirmation of a system (HACCP or PP) that is developed by ex-company specialists. This is one of the many examples that confirm the external communication requirement.

9) With a realist approach, ISO 22000 is filled with a monitoring system, a corrective practice in terms of PP and CCP and numerous details and warnings regarding the ways of recording all these processes.

10) Despite the fact that hazard assessment and

risk management are two of HACCP's building blocks, ISO 22000 reconsiders these terms as force and probability and defines them completely.

11) The difference between the concepts of confirmation and verification is made clear, and the activity of confirmation is detailed as confirmation plan and confirmation result.

12) ISO 22000 contains the concept of suspicion product. It explains the accepted definition and things relating to the issues.

13) It demands improvement of the system when needed and the strengthening of its reliability though updates to be made on the system.

14) ISO 22000, which developed the concepts of recall and withdraw which are associated with tractability, demands that causes and effects of such a situation be explained through the concepts of revision and nonconformity control [11, 12, 13].

3.2. Comparisons of BRC, IFS and ISO 22000

In our comparison, 13 topics are chosen and the similarities and differences of these topics are worked out. The reason as to why these topics are chosen is that these topics are thought to be the most critical topics when it comes to food safety and application of the systems. These topics are enumerated in Table 1 and the articles in which these topics are elaborated are expressed.

Senior Management Responsibility: In all three standards, the creation of a company policy that contains the food safety and quality goals of the company and the training of the all the personnel on this policy, is demanded as the first duty of the management. In addition, in these standards, tracking of the performance of the safety systems is described as a responsibility of the senior management.

Table 1. ISO 22000, BRC and IFS content comparison

1. The Compared Content	TS EN ISO 22000:2005	BRC Global Standard Version 7	IFS Version 6
2. Senior Management Responsibility	Article 5	Article 1	Article 1
3. Human Resources (Personnel)	Article 6.2	Article7 + Article 4.8	Article 3
4. Formation of HACCP plan	Article 7.6	Article 2	Article 2.2
5. Ineligible Product Control	Article 7.10.3.3	Article 3.8	Article 5.9
6. Corrective Practices	Article 7.10.2	Article 3.7	Article 5.11
7. Inspection for and Detection of Foreign Substance	--	Article 4.10 + Article 4.9	Article 4.12
8. Product Release	Article 7.10.3.2	Article 5.7	Article 5.7
9. Product Withdrawal and Recall	Article 7.10.4	Article 3.11	Article 5.9
10. Tractability	Article 7.9	Article 3.9	Article 4.18
11. Customer Complaints	--	Article 5.8	Article 3.10
12. Internal Survey	Article 8.4	Article 3.4	Article 5.1
13. Product Analysis	--	Article 5.6	Article 5.6
14. Audit Protocol	--	Chapter 3	Chapter 1 and 5

The differences are as follows:

1) While BRC and IFS adds to this article the creation of an organizational chart that determines the responsibility of the personnel as the management's responsibility, ISO 22000, in this article, determines the creation of a food safety team and the appointment of a leader to this team, as the responsibility of the senior management.

2) ISO 22000 adds the issues of internal and external communication for the purposes of facilitating the management involvement in emergency situations to this article and determines the creation of such (communicative) systems as the responsibility of the senior management. BRC and IFSs do not specifically make room for the issue of communication.

3) BRC gives a special emphasis to the responsibility of the senior respondent(s) of the production in correcting the nonconformities, by demanding that he or she be present in auditory meetings.

4) IFS recites as one of the responsibilities of the senior management the determination of safety goals with a customer-oriented approach and the creation of a procedure for this purpose.

5) BRC marks the senior management's responsibilities and their duty of perpetual enhancement as a fundamental requirement. On the other hand, IFS marks conscientiousness of the personnel regarding food safety and quality (Article 1.2.4), which the standard enumerates as one of senior management's responsibilities, as a knock out (KO) requirement.

Human Resources (Personnel): In all three standards, requirements regarding the hygiene, training and working environment of the personnel are determined. Differences are as follows:

1) While BRC marks personnel training as a fundamental requirement, IFS marks personnel hygiene as an important requirement.

2) BRC and IFSs make room for the rules regarding protective wear under the topic of human resources. BRC handles the issue more extensively than IFS, while ISO 22000 do not give any room for the issue.

3) BRC deals with the issue of medical tracking in terms of food safety and personnel health.

4) In the section on production plant standards (Article 4), BRC mentions standards and rules for the work environment, social facilities and dressing rooms of the personnel, under the sub-section Article 4.8.

Formation of HACCP Plan: All three of the standards treat in detail the establishment of the HACCP system in light of the *Codex Alimentarius* principles and prerequisite programs.

Differences among the systems are as follows:

1) While BRC defines the whole of HACCP as fundamental requirement, IFS defines only the HACCP article that enforces the formation of a monitoring system for CCP (Article 2.2.3.8.1) as a KO requirement.

2) While it is stated in IFS and BRC that the audit regarding the HACCP plan will take place during announced audits as documentation inspection by the licensing institution, in ISO 22000, the audit for HACCP plan is treated as a matter of internal inspection.

Ineligible Product Control: In all three standards, ineligibility is described as non-implementation of or deviation from a requirement, and is seen as the cause of corrective practices. Their points of divergence are as follows:

1) BRC and IFS requires that a procedure regarding ineligibilities be formed. ISO 22000 does not make such a demand.

2) While BRC distinguishes between 3 types of ineligibilities described as critical, major and minor ineligibilities, IFS separates ineligibilities into two groups of major and KO ineligibilities.

Corrective Practices: All three of the standards require that a procedure be created regarding corrective practices and that these practices be recorded.

Their only difference is that while BRC marks all the articles as fundamental requirements, IFS marks only the documentation of the corrective practice action plan as a KO requirement. In both of the standards, these records are subjected to documentation inspection. Such a case is not present in ISO 22000. However, the attention given to the issue in implementations is identical.

Inspection for and Detection of Foreign Substance: This issue is not defined in ISO 22000. The difference between IFS and BRC on this topic is as follows:

Physical and chemical contamination inspection is treated in Article 4.9 in BRC. It includes chemical inspection, metal inspection, glass or ceramics inspection, wood inspection and fragile plastic inspection, and rules regarding the packaging that is done using these materials. In Article 4.10, the properties of equipment used in detection and sorting out of these foreign substances are treated in detail. IFS deals with these issues in Article 4.12, but does not explain as extensively as BRC.

Product Release: All three of the standards demand that the required analyses are applied and their conformity proven before the final product is released.

1) While IFS and BRC standards require that a procedure be created regarding this issue and the results of the analysis be recorded, ISO 22000 does not set such a requirement.

2) This issue is inspected in BRC within the framework of good manufacturing practices.

Product Withdrawal and Recall: To prevent the release and the consumption of the product or to create a crisis management team that will manage the recall of the already released products, to provide the consumers with proper information and to contact with the consumers as though to recall some product in order to assess the time it takes for the ineligible products to reach the costumers at least once a year, are the common points that appear on three of the standards.

The only difference is that IFS indicates providing the consumer with proper information as a KO requirement. In BRC, product withdrawal or recall is not described as a fundamental requirement.

Traceability System: In all three standards, it is demanded from the certificate holders that all the procedures on the path, from raw material to the final product that reaches the consumer, is monitored and recorded. Differences are as follows:

1) BRC expects from certificate holders that their suppliers' tractability is ensured.

2) ISO 22000 characterizes traceability as a precaution that makes the recall of a product possible.

3) IFS suggests that labelling should be done after packaging for a more precise traceability and that shelf-life should be calculated according to the original production lot.

4) BRC describes traceability as a fundamental requirement and inspects it within the framework of good manufacturing practices, while IFS marks tracking until delivery (Article 4.18.1) as a KO requirement.

5) BRC requires the mass balance test to be controlled at least once a year and the records of these controls to be kept. These records are subjected to inspection under the scope of documentation inspection.

Customer Complaints: The issue of customer complaint is not given a separate place in ISO 22000 and is only mentioned as an example in the discussion of external communication (Article 5.6.1). On the other hand, this issue is worked out in the articles indicated in Table 1 above. BRC and IFS demands the issue of customer complaints to be assessed according to the frequency of complaints and that records of these complaints be kept.

Internal Audit: In all three standards, the significance of internal audits for confirmation and updating of food safety system is emphasized. It is demanded that an internal survey procedure founded

on PP and HACCP is created and this procedure is implemented at least once a year. The articles that cover the topic of internal survey in the three standards are indicated in Table 1 above. While BRC defines the issue as a fundamental requirement, IFS marks the survey of all the plant including the storage areas as a KO requirement (Article 5.1.1).

Product Analysis: ISO 22000 makes a determination regarding the issue of product analysis only in the article where it talks about the establishment of the HACCP system. Table 1 shows places where the issue is covered in BRC and IFSs. According to both of the standards, it is required that the laboratory that is set up for product analysis in the plant or the laboratory from which the service regarding product analysis will be obtained, must fulfill the requirements of ISO 17025 (i.e. (laboratory accreditation for the latter option). It is required that the results of the analysis be acceptable on official level and that these result be recorded.

Audit Protocol: BRC and IFS each deal with audit protocol in one complete chapter. These chapters are indicated in Table 1 above. Such a topic does not appear in ISO 22000 standard. This issue is the most significant advantage that BRC and IFS have over ISO 22000. Differences are as follows:

1) ISO 22000 does not have an explanation for external audits of the system.

2) In IFS' strengthened version 6 published in 2014, unannounced audits are first introduced and are described in the newly added chapter 5 of the standard.

3) IFS divides chosen audit into parts of initiatory audit, renewal audit, proficiency audit and expansionary audit. BRC divides it as initiatory audit, follow-up audit and expansionary audit.

4) BRC distinguishes audits in accordance with their application as announced and unannounced audits, and makes a further dual distinction for the latter, fully unannounced and two-parted unannounced. It additionally has global markets and voluntary module options.

5) In BRC, all the requirements are color-coded (green and orange) in view of the two-parted unannounced audit to show which requirements will be sought after in such an audit. There is no such practice in IFS.

6) 10 articles are given as KO requirements by IFS while 12 articles are given as fundamental requirements by BRC that are watched for during the auditing period. For both of the standards, any violation of these requirements is regarded as sufficient cause for disqualification for certification or, if given, for retrieval.

4. CONCLUSION AND SUGGESTIONS

In the section on Findings, the transition of HACCP system to ISO 22000 system and the points at which the two differ are pointed out, and in this way, the enlightenment of the food sector is intended. HACCP and ISO 22000 systems must not be thought as two distinct systems. Among the advantages of ISO 22000, the following must be noted by the companies.

HACCP is a system whose concern is exclusively about production process. While the segment of HACCP user tend to be food producers, ISO 22000 has become a system that has been employed by producers who produce products that come in touch with food and by all types of institutions that effect food (e.g. producers of animal feed, packaging and food equipment producers, cleaning products producers, institutions that provide storage and transportation services [5]. With its emphasis on the human resources, ISO 22000 manifests its difference by detailing such important issues not only of the hygiene of the personnel but also of the duties of the management, of the inclusion of the personnel into the system, of communication and many more. With a realist approach, ISO 22000 is filled with a monitoring system, corrective practices in terms of PP and CCP and numerous details and warnings regarding the ways of recording all these processes.

Despite the fact that hazard assessment and risk management are two of HACCP's building blocks, ISO 22000 reconsiders these terms as force and

probability and defines them completely. ISO 22000 contains the concept of suspicion product. It explains the accepted definition and things to do regarding the issue. ISO 22000, which developed the concepts of recall and withdraw which are associated with tractability, demands that causes and effects of such a situation be explained through the concepts of revision and nonconformity control [11, 12, 13].

HACCP system, which some companies singularly employ, is open to question regarding its conformity and reliability. This misuse may lead to serious food safety problems. Companies might think that transitioning to the ISO 22000 system is costly, but they must remember that in the long term perspective, it will be a profitable move both economically and in terms of food safety. It is thought that the new features added to HACCP in ISO 22000 for product safety and a systematic production may be convincing regarding change in systems.

As a result of the comparison between BRC, IFS and ISO 22000, it is observed that while BRC and IFS are wider in scope and more in line with one another, ISO 22000 narrower in scope than these two standards. ISO 22000 is seen to be dealing with many of the topics in a more general framework, aside from excluding many descriptions regarding some topics worked out in BRC and IFS. These topics are: assessment for and determination of foreign substance, customer complaints, product analysis and audit protocol. The issue of audits is the most significant among the issues left out. It is seen that BRC and IFSs have given a section about the scope and the application of audits and that BRC has given a more detailed treatment of the issue of audits than the IFS, marking the audit, the requirement of which will be applied, according to its way of procedure. There seems to be no determinations regarding the external audit of a system in ISO 22000.

ISO 22000 does not have an explanation for external audits of the system and lacks any such protocol. The only topic that speaks of audits in the standard is the part where the companies are required to implement the inspection of their food safety systems through internal surveys.

In IFS' strengthened version 6 that is published in 2014, unannounced audits are first introduced and is are described in the newly added chapter 5 of the standard.

IFS divides chosen audit into parts of initiatory audit, renewal audit, proficiency audit and expansionary audit. BRC divides it as initiatory audit, follow-up audit and expansionary audit.

BRC distinguishes audits in accordance with their application as announced and unannounced audits, and makes a further dual distinction for the latter, fully unannounced and two-parted unannounced. It additionally has global markets and voluntary module options.

In BRC, all the requirements are color-coded (green and orange) in view of the two-parted unannounced audit to show which requirements will be sought after in such an audit. There is no such practice in IFS.

10 articles are given as KO requirements by IFS, while 12 articles are given as fundamental requirements by BRC that are watched for during the auditing period. For both of the standards, any violation of these requirements is regarded as sufficient cause for disqualification for certification or, if given, for retrieval.

Audit is the most important guarantor of a system. The proper implementation of a system makes itself manifest during the audit procedure. Among the three standards, BRC is the one to have the most extensive scope regarding this issue. Informing the companies about how to audit of each material helps reduce the errors to a minimum.

In all three standards, the significance of internal surveys for confirmation and updating of food safety system is emphasized. It is demanded that an internal survey procedure founded on PP and HACCP is created and this procedure is implemented at least once a year. However, this practice cannot take the place of audits and helps only for the confirmation of the safety systems internal to the firm.

Another issue where BRC and IFS matters and ISO 22000 does not is the issue of protective wear. BRC and IFSs make room for the rules regarding protective wear under the topic of human resources. BRC handles the issue more extensively than IFS. BRC gives significant attention to human resources. BRC deals with the issue of medical tracking in terms of food safety and personnel health. According to this issue, the health condition of the personnel must be monitored and in case of a contagious disease, contamination of the products must be prevented by taking preemptive measures.

The only issue that BRC and IFS do not cover while ISO 22000 does is the issue of communication. ISO 22000 adds the issues of internal and external communication for the purposes of facilitating the management involvement in emergency situations to this article and determines the creation of such systems as the responsibility of the senior management. BRC and IFSs do not specifically make room for the issue of communication.

Management of nonconformities is an important factor in food safety systems. BRC and IFS requires that a procedure for nonconformities be prepared. BRC divides nonconformities into 3 types of critical, major and minor nonconformities, while IFS divides nonconformities into 2 types of major and KO nonconformities. ISO 22000 does not make any such demand.

The issue of the inspection and detection of foreign substances is not mentioned in ISO 22000. In BRC, the issue is treated and detailed in two articles. Physical and chemical contamination inspection is treated in Article 4.9 in BRC. It includes chemical inspection, metal inspection, glass or ceramics inspection, wood inspection and fragile plastic inspection, and rules regarding the packaging done using these materials. In Article 4.10, the properties of equipment used in detection and sorting out of these foreign substances are explained in detail. IFS deals with these issues in Article 4.12, but does not explain as extensively as BRC.

All in all, the most important common denomination of the three standards is that they all intend to ensure that the consumer is provided with reliable food. EUROPLASTIQUE Quality Manager Nathalie Bernard makes the following comment in an interview regarding BRC, IFS and ISO 22000 standards; “The BRC and IFS frameworks were designed by British and German distributors respectively to set out requirements in terms of procedures and results in the food safety process. However, they are not suited to the whole food chain. ISO 22000, which is highly valued today, promises a food safety system approach based on customer demands. The points that are common to the ISO 22000, BRC and IFS frameworks are good hygiene practice, the use of a HACCP system and a system of traceability. Unlike the BRC and IFS frameworks, the ISO 22 000 standard is based on results and not procedures. The BRC and IFSs are aimed particularly at those who want to work with distributors, while ISO 22000 is aimed at the producers. However, their purposes are the same: food safety for the consumer” [14].

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PREPARETION OF SAFE FOODS IN HOSPITAL KITCHEN AND PATIENT NUTRITION

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Abstract

Food service, which is provided as a common service in the organization of a hospital, is also considered as a medical service. Food service in the hospital is for feeding the staff and also contributes to the treatment process of the patients. Food service at hospitals, apart from the production and distribution process as a catering service also includes controlling raw materials and testing them for their acceptance. All the processes such as selection of menu, procurement of materials, preperation of the meals, and presentation are highly important in food services.

This study has been carried out at a public hospital in Istanbul in order to determine the convenient type of diets for patients and the conditions for assurance of food safety in hospital kitchens for preparation of safe foods for personnel and patients. Food production area of the hospital has been examined according to steps of ISO 22000 (HACCP) system and were followed whether the system rules are applied or not. As it is known, assurance of food safety systems is elimination and prevention of the contamination of biological, physical and chemical hazards from foods. In order to produce safe foods in hospital kitchens hygienic conditions, good infrastructure and well trained personnel are needed and ISO 22000 (HACCP) requirements should be followed.

Keywords: *Diet, food safety, HACCP, hospital food service, patient nutrition*

1. Introduction

One of the most important services provided by the hospitals is food (catering) service. Food service is also considered as one of the medical services for patients in order to support the treatment of patients. It is important to create a suitable diet for both the medical prosecure and the type of illness of the patient for the treatment. Nourishment is the prosecure of taking the right products for growth, strength and daily needs of the body. The ages, sexes and the physical condition of the patients should be taken into consideration for healthy nutrition. People eat obligatory food at places which serve for huge numbers of people like hospitals. That is why there are some regulations for service presentation in a lot of countries. (Baysal et al., 1994)

Previously, permanent personnel of Ministry of Health used to prepare and present food services in the hospitals belong to the government, but now the same job is done by the companies which provide sub-contracted outsource workers. The supervision is completed by a commission which includes members chosen from permanent staff of the hospital.

For the patients staying at the relevant hospital, the kitchen offers full day service by serving 3 main meals and 3 refreshments in a single day. For the staff, there are three meals as breakfast, lunch, and dinner. The menus are created under the control of dieticians monthly and freshness of these suitably prepared meals is checked continuously. Naturally, it is expected to assure the food safety for the production period of the food which is served to the patients and staff.

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Food safety is a chain system constisting of preparation, storage and presentation to the end-user without any biological, physical and chemical hazards and safe food is the food which is free from all kinds of hazardous subtances for consumption. There are a number of food safety management systems for the assurance of food safety in a systematic way. Controlling the raw material to provide food safety in kitchens eliminates the risks which can be faced at previous levels of production. After that, the taken precautions at the kitchen environment provide food safety. Different safe food management systems have been created for safe food production and one of the most efficient and the most common of these is HACCP (Hazard Analysis and Critical Control Points) System.

The food safety standards which are followed in Turkey and in the world can be sorted as follows (Anon., 2007c):.

- The standarts on content and methods of food safety precautions
- The standards used for the production, storage and distribution tools and machines for foods
- The standards for microbiology of food
- The standards for food composition and ingredients.

ISO 22000 Food Safety Management System has been developed for obtaining safe food and it is used worldwide. HACCP principles were taken into consideration while it was developed. Apart from these, ISO 9001:2000 Quality Management System Standards for total quality management and, ISO 13001 Environment Management System Standards for the protection of the environment as well as different kinds of systems can be used (Anon., 2007c).

HACCP System has 7 fundamental principles in worldwide applications. These are:

- Determining the hazards
- Determining Critical Control Points
- Determining Control Criteria and Limits
- Determining Monitoring System
- Determining Corrective Actions
- Verification and Auditing
- Records and Documentation

In an establishmet, the efficency of food safety system should be controlled by the top management continuously at every level of these procedures. Besides, the senior management should provide updates and improvement reports of the system by corrective actions.

Food Originated Health Hazards

A lot of hazards threatening food safety causes food to damage our health. Physical, chemical and biological hazards are the main reasons seen as a threat to food safety.

Physical contaminants in foods can be sorted as shattered glasses, plastic, bon, stone, dusty, etc. These can be contaminated by either environment incidentally or on purpose. These carry the risk of contaminating the food while providing raw material; during production, storage, packaging, transportation and consumption of foodstuffs.

Chemical hazards are originated from chemical substances which contaminate foods during primary production, storage, or heavy metals contaminated by environmental pollutants like mercury, lead and cadmium, dioxins, agricultural pesticides, detergent wastes passed from poorly washed dishes, the chemicals contaminated by food packaging materials, veterinary drugs and overdosage use of food additives (Giray and Soysal, 2007; Erkmen and Bozoğlu, 2008).

Biological contaminants of food can be divided into three categories. First one is the toxic chemical substances naturally formed in the food itself. For example, solanin which is found on potatoes which become green and sprouted and toxic mushrooms. The second group consists of fast replicated microorganisms, viruses and microbial toxins resulting from the lack of sufficient production environment and wrong storage techniques.

Among these, the most dangerous one for human health are bacteria. Some of these are Pathogenic Escherichia coli, *Salmonella, Bacillus cereus, Staphylococcus aureus, Clostridium botulinum, C. Perfringens and Listeria monocytogenes* (Ministry of Health, 2007). These can contaminate the food by microorganisms, dust, soil, air, bugs, pesticides, raw food, wastes, tools used at production and via human. There are a lot of patogen bacteria on human body. Throat, nose, skin, hand, intestines and stools are loaded with bacterias. Because of that, most of the pathogen bacteria contaminate the food by the human himself (Erkmen and Bozoğlu, 2008).

Nutrition of In-patients

Nutrition programmes of in-patients in hospitals are created by taking clinical variables into consideration such as the physical activity of the patient, newly-developed complications, changes on body temperature and infections.

The factors affecting the total energy consumption of the patient:

- Resting energy consumption
- Consumed energy by physical activity
- Diet-induced thermogenesis

Apart from these, septisemi, trauma, burns and illnesses like hipertiroidi can affect the metabolic rate and by doing so it can cause changes regarding the need for energy.

Some of the researches show that energy need of in-patients increases at first, then it reaches the maximum point and decreases slowly (Ishibashi, 1998; Plank, 2001). We can understand that energy need of a patient can be variable, that is why the patient needs to be examined and suitable nutritional regulations should be made.

Picture 1. Food service to a In-patient

The main objective of this study is to investigate the food safety conditions and discuss the ISO 22000 (HACCP) system criterias established at hospital kitchens in order to assure the food safety. In addition, menu planning for patient nutrition, staff nutrition and treatment process have also been investigated. The present study has been carried out at a hospital in the city of Istanbul.

2. Material and Methods

This study has been carried out by taking the suitability of the hospital, the kitchen and patient nutrition process into consideration at a hospital in the city of Istanbul. The kitchen of this hospital provides service for a total of 1000 people divided as breakfasat, lunch and dinner in a day. There was daily breakfast, lunch and dinner services for in-patients. In addition, hospital personnel were also making use of these services.

Food preperation process is carried out by master chefs in the kitchen of the hospital and the supply is provided weekly. The menus are normally divided into two as “normal food” and “diet food”. Furthermore, diet patients are given a service of refreshments three times a day. Daily breakfast, lunch and dinner menu are examplified below in Table 1.

Table 1. Daily Breakfast, Lunch and Dinner Menu

BREAKFAST	**DIET BREAKFAST**
White Cheese / Cheddar Cheese	White unsalted cheese
Black and green olives	Black and green olives
Jam	Tomatoes / Cucumber
Tomatoes / Cucumber	Cracker
Boiled Eggs	Milk Tea
Tea	
LUNCH	**DIET LUNCH**
Vegetable soup	Vegetable soup
Boiled meat	Boiled meat
Bulgur pilaf	Yoghurt
Salad	Salad
DINNER	**DIET DINNER**
Wedding soup	Wedding soup
String beans with meat	Leeks with meat
Rice pilaf	Yoghurt
Cucumber with yoghurt	Sour apple

Foods are cooked by a team of 5 people consisting of a head chef, two chefs and two assistant chefs. Kitchen staff is totally 18 people and they work under the control of a food engineer. The products carried to the kitchen section are transferred into suitable storage rooms, again, under the control of the food engineer. Kitchen settlement plan is given below (Figure 1) and a view from the kitchen is given in Picture 2.

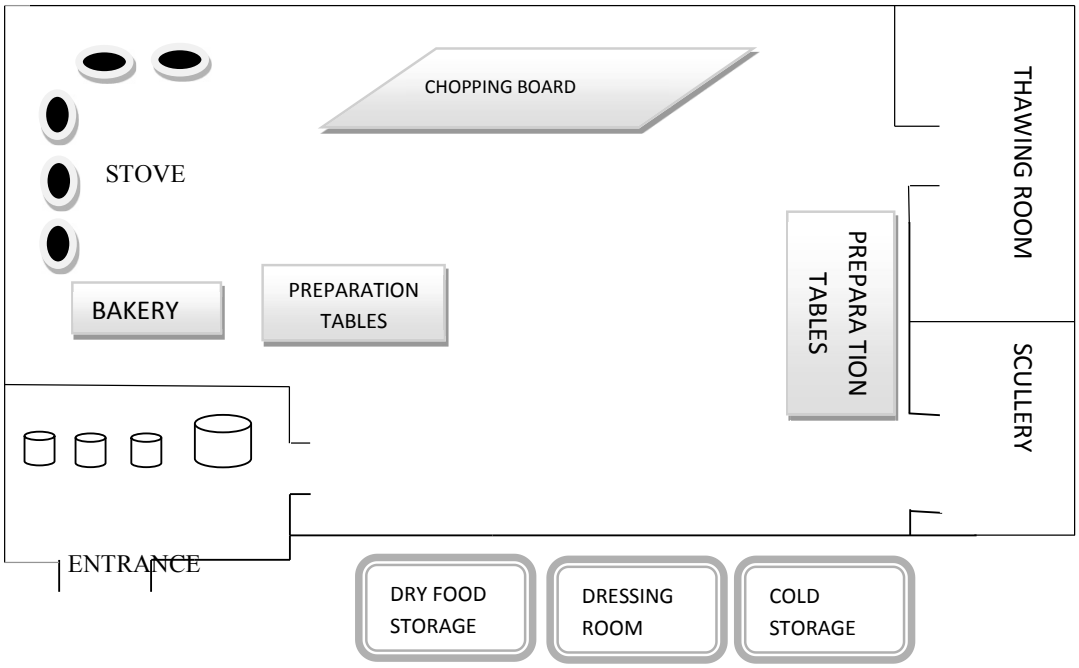

Figure 1. Hospital Kitchen Plan

Picture 2. Food preperation Area

Normal and diet menu examples provided at the hospital as meals during a day are given in Table 2.

Table 2. Weekly Menu Example Implemented at the Hospital

		Breakfast	Lunch	Dinner
Monday	**Normal**	White cheese Mixed olives Butter Honey Tea/Milk	Wedding soup Dried beans Rice pilaf Pickle	Creamed M. Soup Chicken Shish potato salad Ayran
	Diet	Unsalted cheese Mixed olives Molasses with Tahini Milk	Tomato soup Boiled chicken Bulgur pilaf Yoghurt	Yoghurt soup Green bean pasta sour fruit
Tuesday	**Normal**	Cheddar Cheese Mixed olives Tomatoes Peanut butter Tea	Vermicelli Soup Chicken with bechamel sauce Rice Pilaf Ayran	Vegetable soup Kebab with vegetables Rice pilaf Salad
	Diet	Unsalted cheese Mixed olives Jam Tea/ Milk	Wedding soup Staffed squash Kuskus pilaf Yoghurt	Vegetable soup Sauce meatballs Noodles Green salad
Wednesday	**Normal**	White cheese Mixed olives Cucumbers Molasses with Tahini Tea	Lentil soup Green peas with meat Bulgur pilaf Yoghurt	Chicken consomme Spinach Pasta with sauce Yoghurt
	Diet	Cream cheese Mixed olives Boiled egg Tomatoes Diet milk	Broccoli soup Green peas with meat Bulgur pilaf Yoghurt with fruit	Chicken consomme Cabbage Stew with minced meat Yoghurt
Thursday	**Normal**	Cheddar cheese Mixed olives Cucumbers Peanut Butter Tea	Yoghurt soup Hasanpaşa Meatball Rice pilaf Salad	Creamed M. Soup Fish Salad Dessert
	Diet	Unsalted cheese Mixed olives Tomatoes Crackers Tea/ diet milk	Tomato soup Boiled meat Kuskus Pilaf Yoghurt	Yoghurt soup Spinach with minced meat Pasta Yoghurt

Friday	**Normal**	White cheese Mixed olives Boiled egg Jam Tea	Chicken consomme Ispanak Kol böreği Cold stewed fruit	Chicken consomme Mixed fries Pasta with cheese Dessert
	Diet	Creamed Cheese Mixed olives Tomatoes - Crackers Diet Milk	Mushroom soup Eggplant with minced meat Noodles Ayran	Spinach soup Meatballs Bulgur pilaf Yoghurt
		Breakfast	Lunch	Dinner
Saturday	**Normal**	Cheddar cheese Mixed olives butter honey cucumber tea	Yoghurt Soup Meatballs+Potatoes Rice Pilaf Cacık	Wedding soup Mixed Stuffed Peppers Pasta Fruit
	Diet	Unsalted cheese Mixed olives Biskuits Diet milk	Vermicelli Soup Boiled chicken Kuskus pilaf Cacık	Wedding soup Mixed stuffed Peppers Yoghurt Green Salad
Sunday	**Normal**	Creamed Cheese Mixed olives Tomatoes-Cucumber Molasses with Tahini Tea	Tomato Soup Wrapped rice Manti fruit	Vegetable Soup Roasted meatball Rice pilaf Yoghurt
	Diet	Creamed cheese Mixed olives crackers cucumbers Diet milk	Yoghurt soup İzmir meatballs Bulgur pilaf Ayran	Chicken consomme M. saute with meat Noodles Yoghurt

3. Results

The studies have have been started in order to establish the HACCP system in a fully functional governmental hospital in Istanbul. It was seen that for every level from raw material supply to food service, the steps were taken according to the food safety rules and the HACCP system was established to a large extend. Despite the fact that the infrastructure of the hospital was not adequate for HACCP system applications, the available resources were efficiently used for safe food production.

In the hospital building, kitchen is located at the lowest floor of the building and the area is not big enough, but these haven't had hazardous effects on safe food production. When the musts are handled, HACCP System will start its applications systematically.

Maximum population of in-patients and their relatives who eat at the hospital during a day are about 200 people but only a small part of this population eat diet food. Since the consumer population is not so high, it makes the preparation

of safe food easier. Patients are mostly enjoying their foods and that can be seen as an indicator of pruducing good food.

At the hospital where the study was being carried out, not all the HACCP Principles can already be carried out due to the fundamental system deficiencies. Improvements were made in the area for the efficient use the HACCP system. The HACCP Principles currently applied are given below:

- Determination of the Hazards
- Determination of the Critical Control Points
- Defining the Corrective Actions
- Verification and Auditing
- Records and Documentation

To be able to decide the monitoring criteria, limits and control system, it is essential to renew the infrastructure of kitchen section and move it to somewhere else, that is why it can't be applied well. Verification and audition processes are partly applied with available stuff. Apart from this, the quality department of the hospital supervises the kitchen and dining hall in terms of the Quality Standards demanded by the Ministry of Health.

In the food preparation area of the hospital where the study has been carried out, there are astorage rooms for foods such as cold storage, two dry food stores and 2 freezers for pereservation of frozen foods. The products (i.e. raw materials), to be used for food preperations are supplied for the hospital weekly and kept in suitable temperatures. Temperatures of rooms are checked two times a day (one in the morning and one in the evening) by checking a tracking chart. The temperature of cold storage should be about +4 ^{o}C, freezers should be about -18 ^{o}C and dry food storage rooms should be between 10-15 ^{o}C with a relative humidity of 60-65%.

Meat products and frozen foods are kept in freezers and they are consumed by taking cold chain system into consideration. Cold storage room is used for fresh fruits and vegetable products, milk and milk products. Legumes, pasta and oil products are kept in dry food stores. First comes, first goes storage rule is applied to the storages. By doing that, the products are always kept fresh and their high quality is preserved.

Dining hall of the hospital is checked everyday for its cleaning status and hygienic conditions. Hygienic Control Charts are kept by the management. Table 3 shows daily hygien tracking chart for the kitchen.

Table 3. Daily Hygiene Tracking Chart for the Kitchen

	DAILY KITCHEN HYGIENE TRACKING CHART								
WORK DONE	**PERIOD**	**DATE**	**TIME**					**CONTROLLER**	**APPROVED**
FLOOR - SURFACE HYGIENE	3 TIMES		07:00		14:00		20:00		
ULTRA PURIFICATION OF SURFACES	2 TIMES		07:00		15:00				
GARBAGE DISPOSAL	3 TIMES		10:00		14:00		18:30		
CLEANING OF THE MACHINES	2 TIMES		10:00				18:30		
HYGIENE OF TOOLS AND EQUIPMENTS	3 TIMES		07:00		14:00		20:00		

Meals which are prepared daily for the menu are checked for their suitablity and then they are served. Food is checked by the food engineer and noted on food tracking form. Food samples are taken daily and kept +4°C as control samples. Samples are destroyed after waiting 72 hours. Food tracking form is given below at Table 4.

Table 4. Daily Food Tracking Form

	DAILY FOOD TRACTING CHART	
		DATE:…../……./20….
The menus given below are appropriate by ourselves for distribution.		

LUNCH VARIETY	**IS IT APPROPRIATE TO THE MENU?**		**HEAT**	**TASTE**	**VISUAL**	**HYGENE**	**OTHER**
	YES	NO					
RESULT - EVALUATION - SUGGESTION							

For in-patients, 3 main meals and when necessary, refreshments should be served during the day. At the process of service, there are important rules to be taken into consideration;

- The cleaning of the tools used for service such as fork, spoon and plate is of high priority.
- Lined, cracked or broken tools shouldn't be used.
- During service, the food is mixed periodically to make every part of it hot.
- It is suitable to hold the bottom parts of plates and glasses and avoid touching the mouth parts.
- Cooked food should be held for maximum of two hours at room temperature.
- Freshly cooked foods shouldn't be mixed with old ones.
- Spice bottles used at food service should be cleaned regularly.
- Bread is served while being protected from external factors such as dust and moisture.
- Cooked meals are kept over 65°C on water bath and serviced hygienically. By doing that, patients and staff are serviced clean hot meal.
- Napkin, wet towels and toothpicks should be presented during service.
- Isolated patients who have contagious illnesses should be provided disposable plate, fork and spoon.
- Food should be carried with protected moving tools.

The Variety of Menu Prepared in Hospital Kitchen

The diet program for the patients is prepared by taking their illneses, physical and psychological situations into consideration. Lack or imbalance of nutrition may become a very vital problem for the

patients. That is why these diets should be planned and prepared very strickly and they should be checked (Özbek and Fidan, 2010).

The content of the diet should be balanced in terms of protein, carbohydates and fat contents. While doing this, patient's illness and whether s/he has some restriction are considered. For example, carbohyrates can be restricted and fat can be increased for the patients who have KOAH (Özbek and Fidan, 2010). For lactose intolerance patients, dairy products are removed from their diets. If the patient has a problem with his/her digestive system, stiffness of the food can be arranged. By taking the the type of illness into consideration, special diet grouping is made. For the patients who will have an operation, fully functional digestive function is waited prior to giving food. Gas generation from intestines means they start working. After this level, transition diets are applied, then the regular nutrition is started with their own diet. Unless they need to have a special diet, they are given a standard diet having all nutrient groups.

At the hospital, there were some studies on patients who eat diet food and the results are examined as long as the patient stays in the hospital. For example, the system is designed by the results of Glucose, cholesterol and LDL level of the patients who are diagnosed with diabetes mellitus. Blood samples of these patients are the biochemistry group samples and they are analysed by fully automatic AU680, the auto analyser machine which belongs to the hospital where the study is carried out. The system can perform 3 analyses (Glucose, cholesterol and LDL) at once using the same sample. The system is capable of analysing the blood samples of 1200 individuals in one hour. Blood samples are taken when the patients are hungry.

For the patients suffering from *Diabetes Mellitus* who have high blood glucose values, first sugar regulation is implemented, then they are placed in the hospital to be monitored, and then suitable diet is prepared by taking their calorie needs into consideration. Following their stay at the hospital, the in-patients had their suitable diet and 15 minutes walk after every meal, and they had a blood test prior to checking out. In the studied blood tests, there were meaningful recovery seen on their glucose, cholesterol and LDL levels. This situation pointed out that the diet is very important for the patients of *diabetes mellitus.*

Liquid Food Diet

Liquid food is used as the first step for starting eating after the operation and continues until the gas comes out. At room temperature, these foods can keep their liquidity and they consist of liquid grainless ingradients. They don't need to have much nutrient. For example,

Breakfast: Petit Beurre biscuits and tea

Lunch and Dinner: grainless soup, chicken consomme, grainless cold stewed fruit.

Soft Juicy Diet

Soft juicy foods have soft consistency, strongly fibrous and they are easily chewed, easily digested without smell. If the patient is going well, raw vegetable and fruits can be added in the diet. These type of foods can be used for the in-patients having acute infection cases, some gastrointestinal disorders and after operations. In this diet, chicken, fish and meat is not served to in-patients. Also, the foods such as milk, yoghurt, fresh fruits and vegetables are not given to patients because they generate gas. At breakfast, crackers, cheese and honey can be served. Soup, which doesn't cause gas, cream potatoes, rice pudding, grained coldstew fruit or grissini can be added to the menu.

Diarrhea Diet

Patients suffering from diarrhea are encouraged to consume a lot of liquids. Consuming fat is results with the increasing of diarrhea, that is why the foods with lower fats and oil level should be chosen. The meal can be prepared by choosing foods such as boiled chicken meat, non fat pasta, non fat yoghurt or ayran. An example of Diarrhea Diet Menu is given in Table 5.

Table 5. Diarrhea Diet Menu

DIARRHEA DIET	
Breakfast	Non fat white cheese Light tea (without sugar) Bread
Refreshment	Banana or sour green apple
Lunch	Soup (i.e. potato soup) Boiled chicken broom stick – non fat cream potato Boiled Pasta (non fat) – Light ayran
Refreshment	Non fat cheese + 2 pieces of grissini
Dinner	Soup (i.e. yoghurt soup) Grilled chicken breast Boiled potatoBoiled potatoes Light yoghurt
Refreshment	Freshly squeezed fruit juice

Diabetic Diet

The diabetic diet should be a low glycemic diet, and should have the ability to increase blood sugar slowly. It is important to cook the food with low fat content ingredients. Desserts and jams made with diabetic sugar can be preferred. Desserts made with sugar, pure sugar, honey, jam, fruit juice and unknown food are not served. It is possible for diabetic patients to weight more, brown breadt can be chosen as carbohydrate source. Rice should be avoided because it makes blood sugar increase fast. Instead, bulgur can be used. Only fruit itself will make blood sugar increase fast, so in addition to fruit, high proteined food like milk, yoghurt and, ayran are preferred. Moreover, potatoes, rice, white bread, melon, watermelon, fruit juice and dry fruits are foods with high glycemic index. They are not suitable for diabetic patients.

Cardiac Diet

In diets designed for heart care, fries and foods prepared by frying are not consumed. Steamed, roasted, grilled and boiled foods are preferred. Since sodium content of foods is hazardous to the heart, the foods should be prepared with using low amounts of salt. Pickled foods and highly salted foods are not served to the patients having cardiovascular diseases. As a protein source, chicken and fish meat is preferred. Red meat is given at least two days a week. For each meal, vegetable dishes and salad should be served. Dairy products are preferred when they have low fat content. Eggs should be given to patients 1-2 times a week.

Stomach Protection Diet

In stomach protection diet, the food should be neither too hot nor too cold. Spicy and fried foodstuffs are not preferred. In order to speed up the healing of the disease, it is important to consume protein as much as possible. Gassy products like yoghurt and ayran and as well as acidic fruits aren't preferred.

Constipation Diet

For the patients suffering from constipation problem, liquid consumption should be increased for patient nutrition. Pulp consumption is also important too, coldbrewed fruit can be added to the diet. Consumption of bananas, peach and potato cause constipation, so these foodstuffs should not be preferred in the diet. Dry fruits fasten the intestinal mobility due to their fiber content. At lunch and at dinner salad or fruits can be served.

Hypertension Diet

In this diet type, consumption of salt and salty products should be decreased. Thus, processed foods such as olive, pickles, salami, sausage, are not served to the patients as well as fat containg meals.

Cancer Diet

Patients who have advanced levels of cancer disease and who are faced with excessive amounts of weight lost and malnutrition need as spesific nutrition programme. Due to the growing tumor and as a result of the applied treatments, there is a lack of nutrition in the patients. In the cases of stomach and pancreas cancers, weight lost occurs very quickly. These are followed by lung, prostate and colon tumors. Nutritional support does not also increase the adaptation between treatment and patient, but also, increases positive effects of its treatment and, provides important relief for patients who are at metastatic level (Arrieta et al., 2010).

The evaluation of nutrition for a cancer patient starts with diagnosis. Eating habits of the patient are questioned and the changes on the pattern and its reasons are deeply evaluated. After this level, the body mass index and his/her weight should be noted, the changes on weight should be monitored and it should be looked into whether there is a loss in muscle and fat masses in the body.

Cachexia is connected to the response to the treatment and prognose. That is why pharmacological treatment and nutritional support should be provided for cachexia. The aim here is to provide efficient calorie intake and nutrition that is needed for protecting ideal weight to the patient.

Nutrition of Intensive Care Patients

Nutrition of intensive care patients is a very important factor affecting lifespan of the patient directly. The aim here is to avoid occurence of malnutrition. Malnutrition is the occurence of cell loss, disabilities between organs and body integrity caused by lack of food at macro and micro molecular levels.

The surviving chances of the patients who lose about 30% of their ideal body weights during intensive care are highly decreased.

A 70 kg patient having mid-light level catabolism lose 4 grams of nitrogen. To be able to keep normal nitrogen level, 100 gr of nitrogen should be taken into the body. 30-70% of the total calorie calculated for a day should include glucose. The dosage of this should be set to be lower than 225 mg/dL. 15-30% of daily calorie need should be obtained from fats and oils in the diet, remaining 15-20% daily needed calorie should be obtained from proteins and aminoacids (Kartal et al., 2004).

4. Discussion

The catering service in mass consuption places, is a process starting from obtaining the raw material to the service of the food and it always needs to be controlled. The establishment and application of HACCP system in this sector is vitally important for the assurance of food safety. The HACCP system could be flexible in these places as much as possible because of the wide variety of menus, food and preparation methods. Through an effective planning and monitoring systems, improvement of the quality and the assurance of safety in production and service of the foodstuffs can be gathered economically. Moreover, the improvement and development can be achieved by having an effective control system. ISO 22000 Food Safety Management System, when applied in food producing establishments correctly, decreases the problems and provides safe food production.

As for the in-patients, besides having treatment in hospital, their nutrition is also very important. Thus, nutrition process should be followed continuously and the nourishment support should be provided for the patients who are diagnosed with certain illnesses.

A nutrition program is prepared by taking the type of illness and calorie need of the patient into consideration. In the preparation of the diet programme the age, sex and weight of the patient are considered as importants parameters.

During the preparation of the meals for the in-patients, in the kitchen of the hospital, breakfast, lunch and dinner are served daily and these are prepared in accordance to the specified diet programmes of the patients. Safety rules in the kitchen are applied under the control of a food engineer. At research level, it was found out that the raw meals that are provided weekly are fresh products. Daily diet program is prepared by the dietitian with respect to patients' situations.

The needed raw materials and products are provided to the kitchen weekly by the assurence of food safety. Raw products are kept in storage rooms under suitable temperatures according to food groups. In the stogare rooms, "First comes, first goes" rule is a must and it is followed strictly. In the hospital, there are rooms for dry foods, a cold room and freezers. The food is held in one of these environments in terms of its characteristics and it is kept under control.

The products having shorter shelf-life, brought to the kitchen are prepared and consumed in a short time appropriately.

During the preparation of foodstuffs in the kitchen and serving the meals to patients, food safety rules are followed strictly. After pretreatments are applied in the kitchen, products are brought to the cooking process by following the hygienic rules depending on the type of the foodstuff. Cooked meals and raw meals are placed in different places and kept in seperate places for the service. After that, meals are heated with suitable heaters compliant with the rules of hygiene and served by the service personnel to the patiens.

It has been observed that kitchen personnel have participated in several training programmes i.e. seminars that are periodically organised by the hospital management. During these training programmes, the kitchen personnel were informed about food safety, hygiene applications, occupational health and safety, service rules and communication with patients. Also, in order to measure and improve the patients' satisfaction continuously, satisfaction questionnaires are applied monthly. The results are evaluated and necessary improvements are done.

In the kitchen of the hospital, the studies for the establishment of HACCP system has already been started and it is expected to be completed soon.

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AKKERMANSIA MUCINIPHILA; FUNCTIONAL AND PROBIOTIC PROPERTIES IN THE GASTROINTESTINAL TRACT

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Abstract

The development of microbial communities in the human gastrointestinal tract begins immediately after birth. Human gut microbiota is comprised of the millions of bacterial microbial communities that are effective in protecting the health of the host organism and share the common site with the host. At the same time, the mucus layer formed by the epithelial cells surrounding the intestinal surface protects intestines against intestinal external factors and meets the microbiota's need for nutrition. It was found recently that one of the intestinal bacteria isolated from human fecal samples, *Akkermansia muciniphila,* meets the need for nutrition of itself and other bacteria by grafting to the mucus layer and providing the monomer by degrading mucin which is the main component of mucus. *Akkermansia muciniphila,* which has positive effects on human gut microbiota, decreases in microbiota in the presence of certain chronic diseases. Recent studies have shown that decreasing amounts of *Akkermansia muciniphila* was also found in the feces samples of individuals with chronic diseases such as obesity and diabetes, and as well as found in the gastrointestinal tract, too.

Keywords: *Akkermansia muciniphila, gut microbiota, probiotic properties, obesity, diabetes*

INTRODUCTION

The early stages of development in vertebrates are usually seen in chorion, a sterile medium that does not contain any microorganisms. From birth, the microbial ecosystem quickly develops in the gastrointestinal tract and develops specifically with the influence of environmental factors. The evolving intestinal microbiology allows for the provision of energy to the host and the absorption of nutrients, the trophic effect of the intestinal epithelium, the maintenance of the integrity and completeness of the intestinal tract, the maintenance of intestinal homeostasis, and the defense against pathogenic bacteria [1].

The primary function of the intestinal tract is to provide ready-to-use nutrients to the host. The lubricant and protective mucus layer in the intestinal lumen, which develops during the development of the intestinal tract, provides protection of the intestinal lumen as well as host-microbial interactions. Various bacteria attach themselves to the mucus layer and use it as energy and carbon source. So, these bacteria do not have to compete with other bacteria in the intestinal lumen, and they do not need the nutrients that will come from the host [2]. In addition, these bacteria that are mucous-colonized help to restore the microbiota while protecting the host from intestinal microbes [3].

Mucin, a major component of the mucus, is composed of amino acids and oligosaccharides and is a food source for intestinal bacteria. Some bacteria have an enzyme system that breaks down the mucin and prepare the environment for use by other bacteria in microbiota by converting the oligosaccharide chain found in its structure into fucose, galactose, N-acetyl-glucosamine, N-acetyl-galactosamine, sialic acid, sulphate and

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disaccharides [4]. Mucin degradation seems to be a pathogenic event for the gastrointestinal system, but it is used as an energy source in the intestinal microbiota. Only 1% of the colonic microbiota results in mucin degradation. In this way, the source of energy and nutrients are produced for the bacteria that are found in intestinal microbiota and can only use monomers [5]. Mucin degradation provides competition advantage and survival advantages to the host in the absence of nutrients such as starvation, malnutrition and total parenteral nutrition. [6].

Human Gut Microbiota

The concept of human microbiota was first described by Joshua Lederberg in the scientific world. In the definition by Lederberg, microbiota is an ecological community containing commensal, symbiotic and pathogenic microorganisms that are ignored but the determinants of both disease and health conditions, which share a common body area with the host [7].

Colonization of the human intestine with bacteria begins immediately after birth. After a birth canal, a complex population of bacteria begins to form in newborns [8]. Evidence that immediate contact with microbes during labor can affect the development of intestinal microbiota is due to the similarity between infant intestinal microbiota and the vaginal microbiota of their mothers [9].

Intestinal (gut) microbiota is a complex environment that affects the normal structural and functional development of the mucosal immune system in a significant and positive manner and functions like the organ system [10]. The intestinal microbiota consists of trillions of commensal microorganisms that maintain the integrity of the mucosal barrier function in the human intestines. Microbiota is required for the maturation of gut-associated lymphoid tissues (GALT), the secretion of IgA and the production of antimicrobial peptides, which are necessary for immunity. The normal intestinal microbial population varies from 500 to 1000 different species depending on the distal or proximal parts of the intestine, the outer layers from the inner layers, age, dietary habits, geographical origin, delivery pattern, antibiotic therapy and environmental stimuli [11].

The intestinal microbiota maintains a symbiotic relationship with the intestinal mucosa and has important metabolic, immunological and intestinal protective functions in healthy individuals [12]. The intestinal microbiota is active on host living physiology from nutritional status to behavior and stress response. Under normal conditions, the commensal bacteria and the main living organism have many common advantages that protect the intestinal barrier integrity [11]. Bacteria in the microbiota protect the host organisms from outbreaks pathogenic microorganisms. Thus, the host is protected against the outbreak of infections.

Intestinal Ecology of *A. muciniphila*

Akkermansia muciniphila is one of the important bacteria found in the intestinal flora that provides mucin degradation. Metagenome data demonstrate that at least eight different species of *Akkermansia gonorrhoeae* have colonized human intestines other than A. *muciniphila* and that even simultaneous colonization of different species can occur [6]. Subsequent studies based on the cloning and sequencing of the 16S rRNA gene revealed that A. *muciniphila* is also present in stool specimens as well as in different parts of the human mucosa.

A. muciniphila has received the name of Dr. Antoon Akkermans, a Dutch microbiologist recognized for his many contributions to microbial ecology. In 2004, it was isolated in search of the identification of new mucinous bacteria from human feces [6]. It was first found in a fecal sample taken from a Caucasian woman. Later on, in animal studies, they observed the presence of *A. muciniphila* in the feces of animals such as rodents, rabbits, donkeys, pigs and horses, and therefore in intestinal microbiota. This bacterium is the first bacterial species obtained from man that belongs to the *Verrucomicrobia* phylum. *A. municiphila* is an anaerobe belonging to the upper branch of *Planctomycetes-Verrucomicrobia-Chlamydiae*, a gram-negative bacterium present in the intestinal

microbiota [5]. During the isolation phase of *A. muciniphila* the mucin, which is the only carbon source in the environment, is used [13].

A. municiphila uses carbon and nitrogen in mucin as a source of energy. A healthy person has 3-5% of the intestinal flora. The presence of *A. mucinicipila* is greater in colon than the ileum [2]. Factors such as eating habits, race and environmental factors may cause the ratio in the dominant flora to be different. The presence of *A. muciniphila* is inversely proportional to body weight and diabetes rate [14]. The presence of *A. muciniphila* in the microbiota may vary depending on the body weight, the thickness of the mucus layer and the immunity status of the host. These factors also vary in different phases of life and in the presence of any disease that can be seen in the host [15].

A. muciniphila acts as a protective against type 1 Diabetes Mellitus, inflammatory bowel diseases, atopic dermatitis and autism by protecting the body against inflammation through its anti-inflammatory properties which are thought to be possessed. The amount of *A. muciniphila* in intestinal microbiota is inversely proportional to the aging process. In a study on obese mice with leptin deficiency, which were aged 16 and 8 weeks; it was observed that the amount of *A. muciniphila* was lower in 16-week-old mice compared to 8-week-old mice. In the present study, it was observed that as the amount of *A. muciniphila* decreased, the glucose clearance and tolerance decreased, too. The subjects, which were in the study, also had impaired glucose tolerance [16].

A. muciniphila as a Probiotic

Probiotics have been described by the World Health Organization (WHO) and the United Nations Food and Agriculture Organization (FAO) as living microorganisms that have healthy effects on the host organism when given in sufficient quantities [7].

Probiotics may improve the functionality of the microbial community found in the intestines, or may provide useful functions in the gastrointestinal tract. Probiotics can also influence the composition and function of microbial communities through competition for nutrients, production of growth substrates or inhibitors, and modulation of intestinal immunity [7].

Probiotics may inhibit the growth of other microorganisms by producing antimicrobial agents or metabolic compounds, or they may be of interest for the receptor and binding regions of other microbes found in the intestinal mucosa [17].

While there is no adequate study of the use of *A. muciniphila* as a probiotic; however, experimental studies may be developed since it is likely to be a potential probiotic [18]. Experimental studies have demonstrated that prebiotic consumption has a positive effect on the presence of *A. muciniphila,* although there is insufficient evidence to use it as a probiotic. In one study, the presence of oligofructose, which is a prebiotic, was restored with the presence of *A. muciniphila,* and improvement in intestinal barrier and metabolic parameters was observed. In fact, *A. muciniphila* does not evolve only in the presence of oligofructose in vitro. This indicates that the complex cross-nutritional interactions contribute to bacterial growth. In studies on oligo-fructose-consumed rats, it was observed that the number of goblet cells increased, resulting in increased mucus production and mucus layer thickening [14]. The amount of *A. muciniphila* that provides mucus layer degradation also increases due to mucus increase.

Interaction of *A. muciniphila* with diet

It has been debated since the 1960s by the scientific community that the diet directly affects intestinal microbiota. Recently, the distributions of intestinal microbiota and gene content have been examined using animal models to determine the relationship between composition and function of diet and intestinal microbiota. The nutrients consumed during the studies may have direct effects on the microbiota, leading to changes in the biochemical reactions in the intestinal lumen. In studies on mice that do not harbor any microorganisms, mice were transplanted with human feces microbiota and the mice were fed a Western-style diet with high fat

and high sugar content. As a result of the study, it was observed that the intestinal microbiota changes in terms of structure and distribution of species [7].

Different dietary practices and pharmaceutical treatments may have an impact on the amount of *A. muciniphila* in the microbiota. Individuals' eating habits also affect the amount of *A. muciniphila.* Consumption of nutrients and food groups, including polyphenols, fructooligosaccharides, conjugated linoleic acid, oatmeal, resistant starch, fermentable oligosaccharides, disaccharides, monosaccharides and polyols, affects *A. muciniphila* development and amount positively [15].

Contrary to this situation, consumption of high fat diets affects microbiota in the negative direction. The consumption of high-fat diets decreases the amount of *Bacteriodetes* in the intestines and increases the amount of F*irmicutes* and *Protebacteria* bacteria by affecting the intestinal microbiota as well as the formation of obesity. This change in the intestinal flora causes the development of obesity and other chronic diseases. As a result of this change, the energy use and storage capacity increases while the risk of intestinal permeability and inflammation increases. High-fat dietary consumption decreases the amount of *Akkermansia muciniphila* in the intestinal flora, whereas the amount of *Lactoococcus* from the *Firmicutes* bacterial arm increases, contrary to the percentage of increased fat in the body [19]. Gut disbodies, increased levels of fasting glucose and glucose intolerance are seen as a result of this type of dietary intake.

Through the treatment of *A. muciniphila,* the increase in body fat mass, metabolic endotoxemia, adipose tissue inflammation, and insulin resistance caused by consumption of high-fat diets are alleviated by the mechanisms involved in the restoration of adequate intestinal mucus production by the goblet cells. At this point, the barrier function in the intestines is improved. This mucus barrier produced by the goblet cells is supported with antimicrobial peptides that are associated with innate immunity and produced by the Paneth cells.

According to the work done by Elleilde and colleagues, the presence of *A. muciniphila* bacteria in intestinal microbiota has been observed to increase in caloric restriction in humans, mice, hamsters and snakes. As a result of the mucosal analysis, it was observed that the amount of *A. muciniphila* was higher in healthy subjects, and conversely, the amount was lower in subjects with inflammatory bowel disease [16].

Studies have shown that the amount of *A. muciniphila* increased in intestinal microbiota when the fermented or non-fermented form of Flos Lonicera which is used as a traditional herbal treatment in East Asia, was given to rats. An increase in the amount of *A. muciniphila* was observed with the Flos Lonicera supplement, which was fermented or not fermented, although the rats were fed a high fat diet [20].

Beneficial effects of *A. muciniphila* on health (obesity, diabetes etc.)

While healthy intestinal microbiota is important for human health, changes in intestinal microbiota cause chronic and / or non-chronic diseases. Exact evidence shows that intestinal microbiota affects whole-body metabolism by affecting energy balance, intestinal permeability, serum lipopolysaccharides, and metabolic inflammation. This interaction is thought to be related to obesity and related disorders. Obesity and diabetes, which are common worldwide, are characterized by inflammation, intestinal microbiota exchange and intestinal barrier impairment [14]. Therefore, intestinal microbiota is directly related to obesity, type 2 diabetes mellitus and insulin resistance [21].

There are also studies in which *A. muciniphila* bacteria are given as supplements from the outside. In a study of obesity-prone mice, *A. muciniphila* supplements were administered orally to subjects at defined ratios and at specified time intervals. After 1-week supplementation, the experiment was continued for 5 weeks by applying a diet containing high amount of fat and high amount of sucrose. At the end of the study, metabolic parameters of the subjects were improved despite high fat and

high sucrose diets consumed. At the same time, when the body weight and total fat amount of the subjects were examined, it was seen that there was a significant decrease. Biochemical values were found to have significant improvement especially in total cholesterol and triglyceride levels. It has also been shown that insulin resistance, which is also present, is ineffective due to the decrease in glucose and insulin levels [22]. In another study done, *A. muciniphila* supplements did not show any decrease in the amount of *A. muciniphila,* which normally declines in aging process and intestinal flora. At the same time, goblet cells in the intestines and in the villi were observed in terms of both number and density in terms of unit surface area. Compared with subjects with diabetes mellitus supplemented with *A. muciniphila* and subjects with diabetes treated with metformin, the glucose tolerance level was found to be close to each other. However, the same bacterium did not show the same metabolic activity when given at low doses or when the heat treatment reduced the viability [23].

The use of metformin in the Biguanide drug group, which is effective in insulin receptor sensitivity, promotes the growth of this bacterium in vitro, while increasing the percentage of *A. muciniphila* in microbiota in mice [13]. The amount of metformin in the intestinal mucosa was found to be higher than that of other tissues in the body tissues examined in the performed studies. These findings increase the likelihood of metformin having direct and indirect effects on intestinal microbiota and contribute to the antidiabetic effects of the drug. In studies conducted on mice, intestinal microbiota was found to be similar to that of mice fed a normal diet, due to the use of metformin in diabetic mice which are fed a high fat diet (60% fat, 20% protein, 20% carbohydrate, kcal / 100 gr). This decrease was minimized by metformin treatment despite the reduction of *A. muciniphila* in the microbiota of mice that did not receive metformin treatment under normal conditions and were fed a high fat diet. Metformin has been observed to remove the adverse effects of high fat diet on microbiota at this point. At the same time, metformin treatment increased goblet cells that produced intestinal mucosa, and the increase in goblet cells was found to be directly proportional to the presence of *A. muciniphila* [23].

It has been shown that the development of atherosclerosis, one of the main components of cardiovascular mortality, is associated with bacterial infections and intestinal microbiota. When atherosclerotic lesions were examined, it was determined that there are some bacterial species in the lesions or some bacterial DNA strains were found. Pyrosequencing technique has also shown that the lesions are from the oral cavity and the connective microbiota of the bacteria in the lesions. With this finding, it is thought that the direct effect of on the development of the disease [24].

Functional Properties of *A. muciniphila*

A. muciniphila is a bacterium found in intestinal microbiota that provides mucin degradation. The presence of this bacterium in the microbiota is reduced in bowel diseases such as Crohn's disease and ulcerative colitis as well as with aging [14].

A. muciniphila produces energy and nutrients for other bacteria in the intestinal microbiota by producing fucose, galactose, N-acetylglucosamine, N-acetylgalactosamine, sialic acid, sulfate, disaccharides and monomers with mucin degradation. In addition to the benefits provided by the bacteria, mucin degradation provides the opportunity to live for the host when it is not possible to reach the food directly, such as starvation, total parenteral nutrition and malnutrition [5].

Studies have shown that the restoration of the amount of *A. muciniphila* in the intestines led to a reduction in dietary weight gain, a decrease in fat mass and an improvement in fasting hyperglycemia. This effect is due to the fact that in the process of energy metabolism, especially in adipogenesis and fatty acid oxidation in the adipose tissue become proper as it is supposed to be. This effect of *A. muciniphila* bacteria is thought to restore metabolic endotoxemia and adipose tissue metabolism by restoring the intestinal barrier function [14].

CONCLUSION

A. muciniphila is a mucin degrading bacterium that is related to colonic health. By doing mucin degradation, *A. muciniphila* creates an appropriate environment to the other living bacteria. Apart from creating medium for other living organisms, *A. muciniphila* is also linked to chronic diseases such as diabetes, obesity etc. Especially in the chronic disease stage, the ratio of this bacterium decreases and gut flora is destroyed. According to the result of studies, replacement of *A. muciniphila* via supplements provides better prognosis for chronic diseases, like especially obesity and diabetes. Tests that are conducted on animals are promising for the new treatment method for certain chronic diseases. More animal and human based studies may elucidate to the use of *A. muciniphila* as a treatment way.

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Nanotechnology and Smart Packaging in Food Packaging

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Abstract

Increasing consumer awareness of food safety and quality is driving researchers and the food industry to new trends. As a result of the developments in technology, the design and use of materials with different properties have become common today. Some of the developed materials can be modified and / or improved in functions of food packaging. The production of nanomaterials and their combinations with various materials to obtain composites are the most remarkable technologies in recent years and these materials are used in different fields. One of these areas is active and intelligent food packaging systems. Active and intelligent packaging makes more communication possible with the consumer and makes it possible to obtain packages that deliver food in a safer way to the consumer. This review aims to present a brief summary of nanotechnology applications in food packaging and legal regulations for intelligent packaging.

Keywords: *Food packaging, nanotechnology, active packaging, smart packaging, nanocomposites*

1. Definition of Nanotechnology

Nanotechnology is defined as a new industrial revolution of our era and it is thought to affect almost every area of our lives. "Nano" is defined as "a billionth of one physical size". Nanotechnology is the science of understanding and controlling the behavior of a substance at 1 to 100 nanometer dimensions. This degree of control leads to radical innovation in numerous areas [1]. Using new technologic strategies related to nanotechnology is vital in many different parameters including sustainability, environmental concerns, waste valorization, high availability and low prices.

It is not only the dimensions that separate nanoparticles from large materials. These materials also exhibit a different structure from the larger materials in terms of chemical reactivity, energy absorption and biological mobility. In recent years, these materials have begun to take place in the food industry. With nano-technological applications and use of nanocomposites, it is possible to obtain packages that communicate with the consumers and deliver the food in a safer manner to the consumer. However, also the challenges raise on a number of environmental and social issues. Especially, toxicity is one of these difficulties. Given the diversity of scientific studies on this issue, the main purpose of this study is to introduce this new science of nanotechnology, general toxicology concerns of nanomaterials and to increase the awareness of our colleagues [1, 2].

2. Objectives of Nanotechnology

- Analysis of nanometer scale structures,

- Understanding the physical properties of nanometer sized structures,

- Unusually different and superior material properties, production processes,

- More durable, lighter, faster,

- Less material and energy use.

3. Nanotechnology and the Possibilities Provided

One of the most important elements of nanotechnology that is interesting is the behavior of materials when they are nanostructured. Due to the quantum effects, the materials exhibit different properties in nanoscale. For example, while ingot of gold does not want to react with other

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substances, the reverse is observed for gold in nano- scale. Due to this feature, scientists examine different cases in nanoscale materials and try to find solutions [1]. The benefits of nanotechnology can be summarized as follows:

- The possibility of placing each atom exactly at the desired place,

- The possibility of producing almost everything that physics and chemistry makes possible at atomic level,

- Economical production opportunity where production costs do not exceed raw material costs.

Nano-technological products are used within the fields of different sectors such as food, electronics, automotive, paint, textile, health as well as pharmaceutical industry. Current nanomaterials impart additional capabilities and features such as strength and flexibility, water-repellant and/ or absorption, fragrance release, resistance to degradation. The production techniques used today are very crude techniques in the molecular sense. Casting, grinding, turning etc. are based on the movements of atoms in large quantities. By the use of nano-technological manufacturing techniques, the domination of nanoscale materials as stone which is capable of being assembled cheaply with the atoms linking system. With this development, the desired qualities in the food sector and more robust features such as the production of lighter and more sensitive packaging material become possible [3].

4. Packaging

Packaging is defined as a tool that acts as a barrier against external factors, aiming to protect the foodstuffs stored in the interior against deterioration and to introduce them to consumers untouched until the last consumer. Consumer demand in recent years is subject to change in the direction of food protection in its first day freshness by deducting the minimum level preservatives or less environmentally damaging materials with increases in shelf-life [2, 4]. Intelligent packaging technology is a new system used in the food industry and recently a new packaging system whose usage is increasing rapidly. The system is mainly used as an indicator for in-packaging and out-of-packaging to protect the quality of food during storage and to ensure food safety. It shows temperature change, O_2 and CO_2 content, etc. as the freshness bookmarks of food products [2].

4.1. Nanotechnology Applications in Food Packaging

Nanoscience and nanotechnology have a research field with physics, chemistry, biology and engineering branches to process materials in molecular and atomic dimensions. Since the implementation of nanotechnological applications in foods are concerned, the term “nano-food” is defined as the use of nanotechnology techniques or apparatus during the handling, packaging, food production, breeding, etc. Nanotechnology has the potential to be used in all areas of the food industry, from food production to agriculture, food packaging and food supplements [2].

In recent years, most of the nanotechnological research and applications in the food industry are seen in the field of food packaging. In addition, nanotechnology is used for masking the unwanted taste of vegetables, controlling the release of encapsulated active ingredients, vitamins and flavorings, protecting them from oxidation, to identify pathogens and to analyze food safety. The addition of nanoparticles to food packaging for various purposes, package distribution and controlled release of active substances, packaging with antimicrobial agent at the nanometer level, product nanotechnology during transport and distribution, or traceability through packaging containing nanoparticles are among the active and / or smart packaging applications of nanotechnology [2, 6]. In food packaging, nanocomposites usually refer to materials containing generally low additions of some kind of nanoparticles. This application is of particular interest for nanocomposite films containing nanoparticles or modified nano-clays having an active particle typically containing 1–7 weight % and finds wide application in the smart packaging food industry [2].

4.2. Smart Packaging and the Techniques of Smart Packaging Concepts

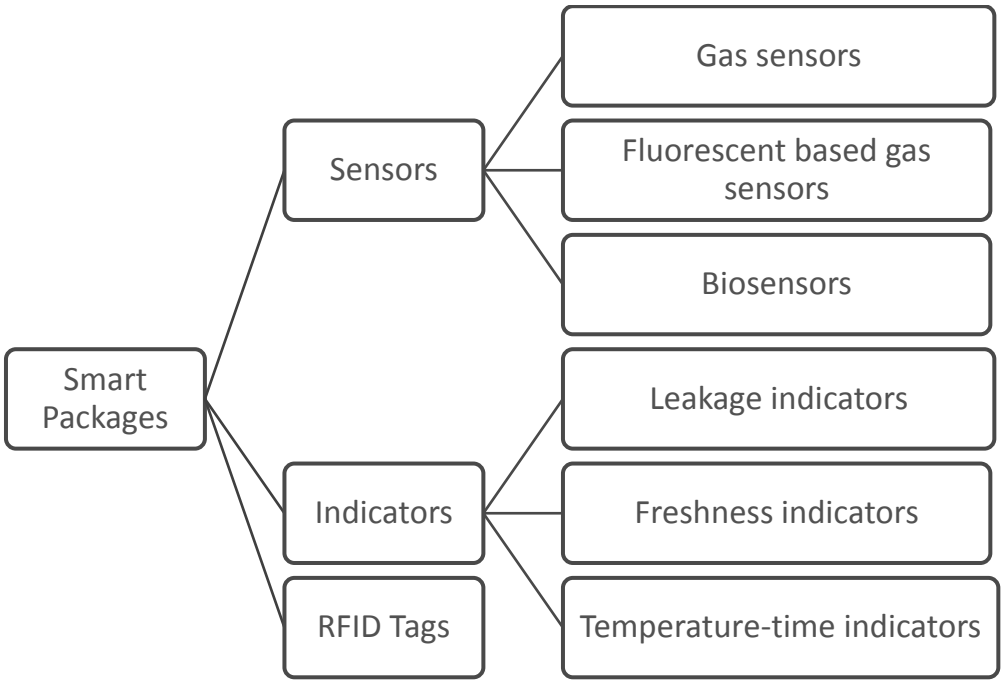
"Smart Packaging" or "Smart Food Contact Materials " is defined as the materials that track the conditions of the surrounding environment of the packaged food. It is designed to convey information about the status of the food to the consumers [2]. Basically, two types exist 1) showing the external conditions of the package and 2) directly measuring the quality of the available food [7]. Smart packaging materials are composed of labels or plugs attached or printed on to the inner or outer packaging material, therefore they provide information related to food. Not only physical features, but also the quantity, type, and amount of data they can carry differ from each other in how they capture and distribute the data. A combination of multiple smart packaging tools can be used in food packaging. In recent years, the use of intelligent packaging has gained importance in order to be able to notice the changes that may occur in food in the early period after the production of foods until reaching the consumer. The classification of major smart packaging that have different structural features are given in Table 1.

4.3. Parts that make intelligent function in packaging

4.3.1. Indicators

Indicators are placed in a two-part pouch and chosen as food-specific. The wall which separates the two parts from each other, dissolves after activation and the parts become united, followed by a color change. As shown in Figure 1, before activation, the first part of the label is white and the part where the indicator is located is green. When the product is exposed to undesirable conditions, a mixed, transition color is observed and the irreversible final color is obtained. After this color is observed, the product must not be consumed as food [8].

Table 1. Classification of smart packaging [7].



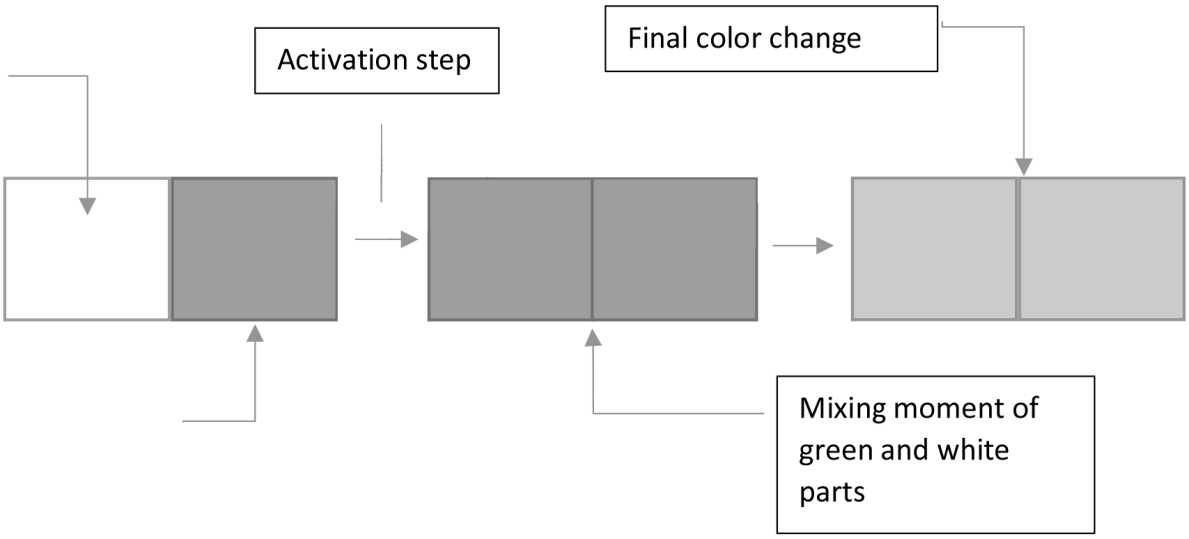


Figure 1. Color change of the indicator at the center [5].

4.3.1.1. Time Temperature Indicators (TTI)

There are available time–temperature indicators that provide time-integrated information about the entire temperature history of the product. Such indicators allow more accurate assessment of the remaining product shelf life [9,10].This indicator can be used effectively through the control of cold chain system. Especially frozen foods, fresh meats, poultry meat, frozen fruits and vegetables, fish, milk and dairy products are highly susceptible to microbial, chemical and physical deterioration resulting from increased temperature. Time-temperature indicator (TTI) systems are divided into the following groups based on working principles [8]: Critical Temperature Indicators (CTI), Critical Time-Temperature Indicators (CTTI), Diffusion Based Indicators (based on Molecular Diffusion), and Polymer Based Time-Temperature Indicators.

4.3.1.2. Freshness Indicators

Working principle of freshness indicators is based on the color change of the label on the food packaging due to the resulting metabolites after microbial degradation in foods. Examples of such metabolites are organic acids, glucose, volatile nitrogen compounds, ethanol, carbon dioxide, biogenic amines, toxins, sulfur compounds, enzymes and sulfur. Such labels are generally used in products that use MAP (Modified Atmosphere Packaging) technology. Freshness indicators are divided into four categories based operating principle [8]. These are as follows:

1) Freshness Indicators Sensitive to pH Change,

2) Freshness Indicators Sensitive to Volatile Nitrogen Compounds,

3) Freshness Indicators Sensitive to Hydrogen sulfide (H2S) and

4) Freshness Indicators Sensitive to Various Microbial Metabolites.

4.3.1.3. Leakage Indicators

Leakage indicators are grouped into two categories of 1) oxygen indicators (generally used in the food sector) and 2) carbon dioxide indicators (used in the pharmaceutical industry). Oxygen indicators ensure that oxygen absorbers operate correctly. They are usually rich in oxidative enzymes. Such indicators often provide information on the leaks of gases that are used in modified atmosphere packaging.

4.3.1.4. Pathogen Indicators

Subsequently, these indicators are used for products infected with pathogenic microorganisms such as *Salmonella* spp., *Campylobacter* spp., E.

coli O157: H7, and Listeria spp. If the product is contaminated, antibodies that are presented as immobilized in the package react with the bacteria and a warning that can be seen by the consumer on the package or the food outer surface is formed.

4.4. Nano-sensors or Nano-biosensors Used in Food Packaging

Sensors used in food packaging provide information about the freshness of products, microbiological deterioration, changes caused by oxidative sting and temperature, and they are most commonly used in biotechnological applications. Sensors basically consist of two parts, the receptor and the transducer. Receptors convert the physical and chemical information they acquire from the source to the energy appropriate for the transducer measurement. Sensors perceive electrical, optical, thermal and chemical signals. They are mainly grouped into three categories; 1) Gas sensors, 2) Fluorescence based sensors and 3) Biosensors.

The sensors of oxygen and carbon dioxide gases are among the most commonly used gas sensors to monitor the quality of the food. These sensors are required to contact with the gaseous medium in the package and thus are in direct contact with the food. In fluorescence based sensors, the oxygen polymer in the food package penetrates through diffusion and ensures the luminescence of the package. The oxygen level in the medium is determined by measuring the luminous parameters. Ruthenium, phosphorus palladium (II) and platinum (II) -phosphorine complexes are used in fluorescence based sensors. Biosensors may be defined as bioanalytical devices developed by combining biological molecules or biological systems with modern electronic technical systems that are composed of a bio-receptor and a transducer [5].

4.5. Nanomaterials Toxicology

Unlike larger particles, nanoparticles can easily migrate from skin and similar biological membranes. Thus, they penetrate into various cells, tissues and organs in the body. They can also be transported to other vital internal organs and tissues, when mixed with blood. According to the hypothesis; when a large number of nanoparticles enter the body, they overload the phagocytes and trigger stress reactions, which leads to inflammation and weakens the body's defense mechanisms. In addition, they increase the formation of free radicals due to increased chemical reactivity, which can cause damage to proteins, membranes and even DNA (which can cause mutations in cells and subsequent cancers, like other DNA damage-causing materials). Today, however, nanomaterial toxicities and effects on the organism are still undefined for many. The information is still an assumption [12]. Moreover, dosage is another concern since nanoparticles are involved in food in quite small amounts that are considered as under limit [13].

4.6. Legislation in Intelligent Packaging in Turkey and Europe

Packaging laws and regulations are generally grouped into three categories throughout the world: safety of packaging materials, labeling of packages, and environmental impacts of packaging [14]. Although in Turkey; there are still no regulations on the toxicology of nanomaterials; most of the developed countries in the world, including the European Union and the US, conduct a lot of research on nanotechnology and prepare legal regulations with the finest detail. However, because Turkey is a country in the EU accession process, the standards and directives published are to harmonize, their environmental conditions to Turkey. Preparation of the mentioned regulations is inevitable for the Ministry of Industry and Commerce and Labor and Social Security, as well. At the moment, there is a very limited compulsory labeling of products containing nanoparticles and they are quite new since they have just been prepared after the legal authorities issued a guidance and/or recommended a definition on nanoparticles [12].

5. Results and Recommendations

Freshness in foods from production to consumption and quality control of the other features may not be always assured. Intelligent packaging technology is useful for both the protection of the

consumer's health and avoidance of economic losses. With intelligent packaging technology and nanotechnology, information about the freshness of the food and whether the proper temperature - time is applied in the storage can be obtained at all stages of distribution and storage.

However, with the many new advantages of this technology, the disadvantages or other health effects have not yet been fully understood. For this reason, the national and international legal regulations required for the production, control and safety of nanotechnology products must be brought to life in the shortest possible time. Thus, the concerns due to the use of these products may be resolved and maximum benefit from these products will be provided.

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