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INDUSTRIAL USE OF FOOD WASTE

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ABSTRACT

Food waste is one of the issues whose significance is increasing day by day in the global arena and has become a problem in many environmental, economic, and social areas. Wastes, such as fertilizer and water spent, during the production phase, occupation of the soil, time and effort spent in transportation and cooking processes, pollution of the natural environment, and the risk of not being able to obtain enough food in the future are some of these problems. Recycling, reusing, and minimizing food waste are important for a sustainable life. In this study, the use of waste food in different industrial areas (e.g., health, fashion, gastronomy, fertilizer production, natural preservatives, paint industry, bioplastic, packaging, biodiesel production, and cosmetics) was investigated. The data obtained in the present study were collected and compiled by literature review from secondary sources. It is expected that this study will be a basis for preventing uncertainties about food waste and for waste management practices.

1. INTRODUCTION

Foods, many environmental and economical in the process from the production stage to the consumption process encounter losses. Processing of resources with minimum loss and food produced during production re-evaluation of waste is associated with the concept of sustainability.

The concept of sustainability is expressed as maintaining, the ecological order or any order that is sustainable without being disrupted, without encountering the risk of depletion as a result of excessive consumption and without overloading on existing resources (Aslan, 2022: 8). The main point of this concept is to prevent environmental problems caused by technological and economic developments and to protect the ecosystem.

The concept was officially included for the first time in the document called the World Charter for Nature, published by the IUCN (World Union for Conservation of Nature) in 1982. In this document, which is considered in a global framework, living beings it emphasizes that the resources found in the ecosystem, sea, atmosphere and land that it consumes should be managed sustainably. This process should be carried out in a way that does not endanger the integrity of the ecosystem and the lives of living beings (Mengi and Algan, 2003:19). In the Brundtland Report entitled "Our Common Future" published by WCED- World Environment and Development Commission in 1987, three dimensions of the concept of sustainability were mentioned. According to the report, the 3E of sustainability consists of the concepts of environment, economy, and equality (Ağcakaya and Can, 2019: 791-792).

Among the concepts included in the report, the environment is the one that is mentioned the most decently. Environmental sustainability is defined as minimizing food waste in production areas, increasing efficiency in resource use and ensuring that resources are also used by future generations (Mazurkiewicz, 2005:2). In the economic branch of sustainability, he emphasizes that businesses or individuals should adopt an attitude towards the needs of future generations rather than a win-win (maximum profit-making) philosophy. Minimizing expenses and spending balanced thinking about the future is related to the economic dimension of sustainability. In the dimension of equality, it includes making individuals sensitive and respectful of cultural elements, protecting public health, and raising more conscious individuals through educational services (Ağcakaya and Can, 2019:792).

Uncertainty is an important phenomenon in today's modern structure (Işık et al., 2019: 9). The amount of food waste, the depletion of resources, the negative effects on the environment and the attitudes towards waste food in the future cause uncertainty in the current situation. To minimize this uncertainty and follow a sustainable policy, waste food needs to be re-evaluated. In this study, regarding the use of food waste in different industrial areas, the relevant information was collected by conducting a literature search from

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secondary sources. First, the concepts of waste and waste management were examined and their place in the circular economy was tried to be revealed. Besides, applications related to reintroducing food waste into the economy have been determined. As a result of scanning the secondary data and examining the studies, it is aimed to contribute to the relevant literature by developing new suggestions. This study we have conducted is considered crucial in reducing environmental pollution and creating awareness that food waste can also be evaluated in different sectors

1. FOOD WASTE AND WASTE MANAGEMENT

Substances and materials that are left to nature thrown away or have to be disposed of by producers, real or legal persons are called waste (Sıfır Atık Yönetmeliği, 2019). If the wastes are in food grade, food losses are evaluated in three groups as food waste, food loss and food squander (Çirişoğlu and Akoğlu, 2021: 39).

Food waste, is defined as the food losses that occur at the end point of the supply chain. Food waste is generally a concept related to people's behavior. Food waste, edible waste and it is divided into two groups as non-renewable waste. Edible food wastes include damaged products and edible food that is thrown away. Excess needs arise due to reasons, such as purchase, the size of the portion amount and insufficient storage. Non-renewable food waste refers to the parts of food that are unfit for human consumption. The skins of fruits and vegetables, bone fragments, coffee grounds, eggshells and excess fat of meat are examples of this group (Çirişoğlu and Akoğlu, 2021: 39). Food loss is a decrease in the quantities of food and beverages in the supply chain, or it also refers to the occurrence of losses in product quality. Casualtiesduring the production phase can occur in fields or greenhouses, in post-production blending or storage, and processed food can occur in industrial facilities, during the distribution process and consumption process (Demirbaş, 2019: 627). If food squander is as the processed foods become unusable due to faulty applications or the foods are wasted during consumption (dishes left on the plate, the food is not liked…) (Erik and Pekerşen, 2019: 419). Food waste is a general concept that includes both food waste and food losses (Çirişoğlu and Akoğlu, 2021: 40).

Wastes are substances that harm the environment and human health. Along with population growth and economic growth, the amount of waste is increasing every day. The fact that wastes cause many environmental, economic, and social problems and the existing resources are depletable has led to the need to manage/evaluate wastes (Aydın and Deniz, 2017: 436-437). Collection of waste, reduction of waste formation, recycling and reuse, temporary storage, classification according to type or characteristic, disposal, post-disposal monitoring, control and supervision of waste is defined as waste management (Atık Yönetimi Yönetmeliği, 2015).

Waste management is a form of management that covers processes, such as minimizing household and medical wastes, separating, and collecting them at the source, creating transfer points, when necessary, transportation, disposal, recycling, control and monitoring (Öktem, 2016:138).

2. CIRCULAR ECONOMY

Wastes generated because of population growth, urbanization, industrialization, technological developments, and rapidly increasing consumption; while bringing environmental problems with them, they also negatively affect human and community health (Palabıyık and Altunbaş, 2004:103). To avoid these problems, to use resources effectively and prevent waste, the concept of "circular economy" comes to the fore.

Experts, because of constantly increasing water and carbon footprints, emphasize the importance of renewable, regenerative, sustainable, and restorative operations day by day and propose to benefit from the circular economy paradigm (Açıkalın, 2020: 240). According to the definition made by the European Union, the approach in which materials, products and resources remain in the economy for as long as possible and with minimum waste is called the "circular economy." The basis of this concept is edible energy, restorative industrial economy, minimization of toxin use and avoiding waste (Önder, 2018: 199). 3R concepts are used when defining circular economy. They represent the concepts of <<recycling, reuse, and reduction>>, respectively (Liu et al., 2017:1315).

- Recycling: It is the reprocessing and evaluation of a used product as a result of which it becomes unusable. In this process, the products that are evaluated as waste are divided into parts and turned into new products (Zhu et al., 2008: 125). Thanks to recycling, the concept of the waste product has ceased to be a non-us product and entered the literature as an efficient and profitable product (Akdoğan and Güleç, 2007:41).
- Reuse: It is defined as repairing, renewing waste products or using them in the production of a different product (Index, 2018:200).
- Reduction: It refers to the minimization of wastes generated at every stage of production and consumption activities (Önder, 2018:200).

3. INDUSTRIAL RECYCLING OF FOOD WASTE

20. with the machines that have entered our lives with the industrial revolution of the century and the diversified raw materials, the production process has accelerated and the tendency to consumption has increased in the right proportion. Over time, the unconscious consumption of raw materials and the rapidly increasing environmental pollution have caused some problems that cannot be prevented. Thus, consumers have started to look for sustainable solutions to use resources with maximum efficiency and transfer them to future generations (Berber and Keskin, 2021:144). The re-evaluation of waste food within the scope of sustainability and its use in different industrial areas are explained in detail below and supported by examples.

3.1. The use of food waste as an alternative artificial leather

The use of waste food in the sustainable fashion industry is becoming important every day. Especially recently, many well-known brands in the fashion sector have turned to plant-based vegan leather in line with sustainability (buddyatelier.com). Vegan fashion, an alternative in the fashion sector in the name of the non-exploitation of animals, has become a significant business line in the field of sustainability

by transforming from micro-scale to macro-scale (Berber and Keskin, 2021:145).

Table 1 Examples of the use of food waste as an alternative leather

 MIANQA BRAND **BAG MADE WITH APPLE PEEL** (lidyana.com)	 NIKE BRAND **SHOES MADE WITH PINEAPPLE** (greenqueen.com.hk)	 H&M BRAND **SANDALS MADE OF CACTUS LEAVES** (www2.hm.com)
 **SAYE BRAND** **SHOES MADE OF MANGO** (www.sayebrand.com)	 WAMA BRAND **UNDERWEAR MADE OF HEMP** (wamaunderwear.com)	 S. CAFE BRAND **CLOTHES MADE FROM COFFEE WASTE** (bigumigu.com)

As shown in Table 1, most companies or brands are aiming at sustainability. They have started to make alternative leather, fabric, and fiber in the field of textile and fashion by recycling the wastes of products, such as apple, pineapple leaves, corn, cactus leaves, citrus peel, ground coffee waste, mango, banana peel and hemp.

In 2011, two companies named Orange Fiber and Lenzing produced TENCEL™ brand sustainable fiber using waste materials, such as orange and wood peel. The main goal of the company is to revive waste food, protect nature and achieve transparency in the fashion and textile sector by achieving sustainable industrial activities (orangefiber.it).

Figure -1
The process of transformation of orange into fiber

Figure -2
Leather made from grape stalks, husks, and seeds.

Vegea™ is another company working in the field of sustainability. The word "veg," which makes up its name, represents veganism, and the word "gea" represents birth from the mother. The company, in cooperation with Italian wineries, has produced an alternative herbal skin using the stems, seeds and skins of the grape used in winemaking. This skin obtained does not contain heavy metals and other harmful substances (www2.hm.com)

3.2. Recycling of food waste as food again

When it comes to recycling food waste, one of the first things that comes to mind is citrus waste. Citrus fruits with a high amount of vitamin C create extreme amounts of waste because of processing in fruit juice production (using only their pulp) or decomposing and disposing of them for commercial reasons (damaged, rotten fruits) (Akçay, 2022:16). The shells of these foods are evaluated in the production of jams and marmalades, as flavoring agents in teas and desserts, or for drying and later consumption. (Yaman, 2012:343 and Akçay, 2022:16). In addition, the presence of a high amount of pectin in citrus peels shows us that it can also be evaluated in the production of pectin. Thanks to the pectin contained in the shells, it is used to increase the consistency of different products and create gels (Köse and Bayraktar, 2018:11). The seeds of various fruits and vegetables are used in raw/roasted, salted/unsalted cookies, as well as in breakfast products, side dishes and decorations of cakes and bread, and salads (Tuna, 2015:15).

A high amount of whey (70-90% of milk) is formed at the end of the cheese production process. Using

whey juices in mayonnaise making, cream cheese making, salad and meat sauces, the nutritional values and taste of these products can be improved. In addition, whey can be ground into powder and used as a food additive in areas such as ice cream, biscuits, and chocolate (Yağcı et al., 2006: 500). During sugar production, high amounts of food wastes called molasses are formed. These wastes are processed and used in the production of ethyl alcohol, baker's yeast, and lactic acid (Şener and Ünal, 2008: 1036).

One of the foods that have been recycled recently is fish. Fish waste (e.g., head, scale, bone, shell, blood, and viscera) contains abundant collagen. Natural transparent gelatins are produced with these colleges. Gelatins, which are especially evaluated in the halal food sector, are preferred by different faith groups and are important for recycling waste food (Bozkurt and Yüksel, 2019:11). In addition, the residues formed in fish processing facilities are used in the production of fish meal. The water and oil in the waste fish pieces are removed from the environment, and a drying process is applied. It is then ground into flour. These flours contain high levels of amino acids. Therefore, fish meal is often used in feeds produced for animals, such as chicken, cattle, and fish. The oil separated from the fish during this process is used in the production of fish oil. In addition to being a tremendous energy source, fish oil, is also rich in calcium, magnesium,

vitamins and phosphorus. Hence, it is used as a supplementary product in baby foods, functional foods and beverages, and diet products. Experts say that fish oil consumption has a protective effect on cancer, hypertension, cardiovascular disease, inflammatory disease, and immune system diseases (Çolakoğlu and Künili, 2016: 59).

Activated carbon is defined as carbonaceous material with high porosity or surface area that cannot be determined by chemical analysis or structural formula (Orbak, 2019: 5). Activated carbon can be consumed orally and is usually of food waste origin. Examples of materials

used in its production are banana peels, olive seeds, starch, cherry seeds, chestnut peel, tea waste, fruit waste, fish waste and corn cob. Activated carbons are used as food additives to absorb toxins in the body and give color to foods (Ülkeryıldız Balçık et al., 2020: 220-221).

Another example of the re-transformation of food waste as food is in the field of 3D food printers. Industrial design student Elzelingen Van Doleweerd studying at the Eindhoven University of Technology and 3D Food company has used food waste in 3d food printers to prevent food waste. Elzelinde, who is sensitive about not wasting food, noticed that people living in China

waste rice at a high rate. Moreover, she obtained a printable food paste using waste rice (3dprint.com, 2019).

3.3. Use of food waste in other areas

The following table gives examples of the uses of food waste in different areas.

Table 2 Use of food waste in other areas

Usage Area	Purpose of Use
Compost (Organic Fertilizer)	Carrots, potatoes, cucumbers, onions and fruit peels, fruit pulp, coffee, and tea, their pulp and eggshells are evaluated as compost (organic fertilizer) (Yaman, 2012:341). Composts have many benefits, such as reducing the use of fertilizers and pesticides used in agriculture, increasing the amount of humus in the soil, preventing weed growth, increasing crop yield, reducing the water requirement of the soil, increasing the worm population, and preventing plant diseases (Keskin and Baran, 2021: 95-96).
Natural Protector	Recently, food waste has been used to extend the shelf life of food. Uçak (2019) in his study used a high amount of onion peels since it contains flavonoids and has high antioxidant and anti-microbiological effects; he thought that it could be used as an alternative preservative in foods and made studies to extend the shelf life of fresh shrimp. The findings showed that onion peels provide acceptable protection for up to eight days. Another example of food waste used as a preservative is eggshells. Egg shells are especially used in ceramic products, such as pottery and pottery, for glazing (ensuring that air and water are not passed into the interior) and beautifying their appearance. In addition, thanks to the eggshell, glossy or matte surface glazing can be made in green and brown tones without using any colorants (Kum and Poyraz, 2022: 51).
Paint Making	Environmentally friendly natural dyes have reached the potential to compete with synthetic and cheap dyes in the world market. In addition, the wastes generated during the processing of natural dyes are used in the production of organic fertilizers and energy. This situation makes natural dyes valuable as a sustainable product (Keşmer et al., 2020: 57). In paint production, foods, such as onion peel, quince leaf, almond leaf, wild cherry peel, corn tassel, walnut leaf and shell, acorn, wild cranberry peel and vine leaves, are used (Etikan and Ölmez, 2014: 54; Kashmer et al., 2020: 57; Yılmaz, 2020: 1186).
Bioplastic Making	With the environmental pollution caused by disposable plastics reaching significant levels, cheap and sustainable alternatives have started to be sought. At this point, bioplastic materials made from food waste have gained value as an innovative approach. In their study, Özel and Erdem İşmal (2022) worked on converting waste food into bioplastics as an environmentally friendly alternative. They used avocado seeds, tomato skins, watermelon skins, lemon peels, tangerine peels, banana peels, cucumber skins, artichoke leaves, purple cabbage, purple onion skins, beet stems, yellow onion skins, radish skins, almond skins, and pomegranate peels. As a result of their study, they concluded that bioplastics can be made in different appearances textures, and colors by adding fiber to waste materials
Packaging Material Making	Since food packaging produced using petroleum-based polymers is not sustainable, biodegradable packaging (which is not harmful to nature and can be reprocessed) has been developed recently. Biodegradable packaging has started to be produced from many food wastes, such as orange peel, soy protein, sugar beet pulp, potato peel, corn starch, pomegranate peel and lemon peel. Biodegradable packaging reduces environmental problems, supports sustainability, and makes waste food economically valuable (Karakuş and Ayhan, 2019:1008).
Cosmetics	Cosmetics is the science that deals with materials that beautify the whole or part of the body or make it look clean. Many waste
Its Use in Biofuel Production	Biodiesel is an alternative fuel obtained from renewable sources (plant and animal) (Alptekin and Çanakçı, 2006:58). Abali
Its use in the field of health	Waste parts of food, called shells and core, are used to treat some diseases. Examples of the use of food waste in the health sector are stated. The drug named LaetrileTM, obtained from apricot kernels, is used in the treatment of cancer in countries, such as Mexico and America (Tuna, 2015: 9-13). The membrane parts of the eggshells are used as a nutritional supplement and serve as superior protection against harmful bacteria. It is an important calcium store for the body. Also, the eggshell membrane is used in wound closure, surgical implants and producing biomedical bandages (Yüceer, 2021: 43-44).

CONCLUSION AND RECOMMENDATIONS

Food and beverages experience many losses in the process until they reach our table. Many reasons, such as the increase in the development level of countries, the widespread use of social media, easy access to food and unconscious consumption, cause consumable food to turn into waste. While these wastes negatively affect sustainability,

social, environmental and creates severe economic problems. The most basic way to eliminate these problems is to ensure the recycling of waste.

Recycling is the breaking down of a product that is in a state that will not be used and reprocessing it and making it efficient. Recycling and evaluation of waste food provide added economic value but also avoids environmental problems. In this study, the recycling of waste foods and their use in different industrial areas were compiled. This study shows that environmentally friendly natural dyes are made by recycling waste food, used to extend the shelf life of food, evaluated as fertilizers, sustainable bioplastic materials are made instead of disposable plastics to reduce environmental pollution, biodegradable packaging that does not harm nature is developed, medicines are made from the shell and core parts of food and waste food is used in the construction of some equipment used in the field of health. Recycling and reuse of food waste in different areas is very important for a sustainable life.

Waste management will be effective in preventing uncertainties in the food policies of both businesses and countries. Especially regarding sustainability, industrial use examples of food waste are very important in terms of the efficient use of resources and their transfer to future generations. Increasing these examples will allow for increasing environmental awareness and the spreading of recycling. For these developments to be experienced, it is expected that central and local governments will focus on the issue effectively and lead efforts to increase the level of awareness. Especially the central administration; should provide coordination between the parties of the issue by leading the planning, management, and administration. Local government and non-governmental organizations should take part in the implementation and project design phase of this coordination. In this context, local government studies, workshops and project competitions should be organized. They should set up waste collection and separation systems within their jurisdiction and mobilize food and restaurant businesses in this regard. While local governments take on the role of regulating and supervising the systems, non-governmental organizations should make active efforts to raise awareness of society and businesses on this issue. Societies with a high level of consciousness and awareness will play an important role in the sustainable transfer of resources to future generations. All these studies will contribute to the transfer and effective use of resources from today to the future under the coordination of the central administration. This study and further studies will contribute to increasing the level of consciousness and awareness.

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