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ZERO WASTE MODEL IN FOOD INDUSTRY OF SERBIA

Veljović Mile[1,2*], Kalušević Ana[2,3]
[1]*University of Belgrade, Faculty of Agriculture, Department of Food Technology and Biochemistry,* Belgrade, Serbia
mile.veljovic@agrif.bg.ac.rs
[2]*Serbian Food Technology Council,* Aleksandrovac, Serbia
[3]*Academy for Applied Studies Belgrade,* Belgrade, Serbia
ana.kalusevic@vhs.edu.rs

Abstract

Zero waste is a core principle of the circular economy model. Simplified, it is a design principle that *minimizes waste, reduces consumption, maximizes recycling, and ensures that products are made in that way to be reused, repaired or recycled back to the nature or the marketplace*. Awareness campaigns are needed to change behavior of all participants in the food chain: from primary agricultural producers via the food processors to the consumers. Successful food waste management and shift toward circular economy can only be achieved through a comprehensive approach. What is the situation in Serbian food sector? The recycling industry is at the very beginning, and a very small amount of by-products are further processed. The largest amount of by-products (fruit pomace, seeds and pits, stems ...) is disposed of as waste, while a certain amount is used as combustion fuel. The main focus of this study is utilization of fruit and vegetables processing by-products/waste.

Keywords: zero waste concept, food industry, Serbia

INTRODUCTION

"The conservation of all resources by means of responsible production, consumption, reuse, and recovery of products, packaging, and materials without burning and with no discharges to land, water, or air that threaten the environment or human health." is a definition of the *Zero Waste:* updated by the Zero Waste International Alliance (ZWIA) board less than two years ago (December, 2018).

Some of the Zero Waste concept' goals generally emphasized are: (a) redesigning of the existing (*one-way)* industrial system into a circular system; (b) helping the communities achieve a local economy that operates efficiently, (c) eliminating instead managing the waste, (d) challenging the business systems designed in terms to use *too many resources to make too few people more productive.*

The circular economy, as well as the term of the Zero Waste, should not be recognized or changed with recycling. These concepts are much broader and more comprehensive terms. Circular economy implies generation from waste, repairing and reusing of the already used, production from existing

product/byproduct/waste with reduction of energy consumption, as much as possible etc.

One of the key and relevant EU policies is the data from 2014 – "Towards a circular economy: A zero waste program for Europe". This document sets out a common and coherent EU framework for the promotion of circular economies. Above-mentioned includes: (1) providing a framework for policy-making, (2) changing the policy of waste management, (3) increasing recycling and preventing the loss of valuable materials (4) creation of business opportunities, investments and economic conditions, (5) new business models, design and industrial symbiosis to achieve zero waste rate (6) reduction of GHG emissions and environmental impact (Franco-Garcia et al., 2019).

The food industry produces significant amounts of biodegradable wastes. For instance, over 220 million tons of food-related waste are disposed of annually in Europe. As a consequence of better environmental awareness, the food industry is facing increasing pressures to reduce food processing and related wastes (for example through legislation like the EU Council Directive 1999/31/EC). Therefore, methods to (1) reduce waste production, (2) valorize unused co-products, and (3) improve the management of unavoidable wastes, are becoming essential to the food sector.

Figure 1 shows a diagram of the production of waste materials from the food sector and highlights criteria consistent with the waste hierarchy.

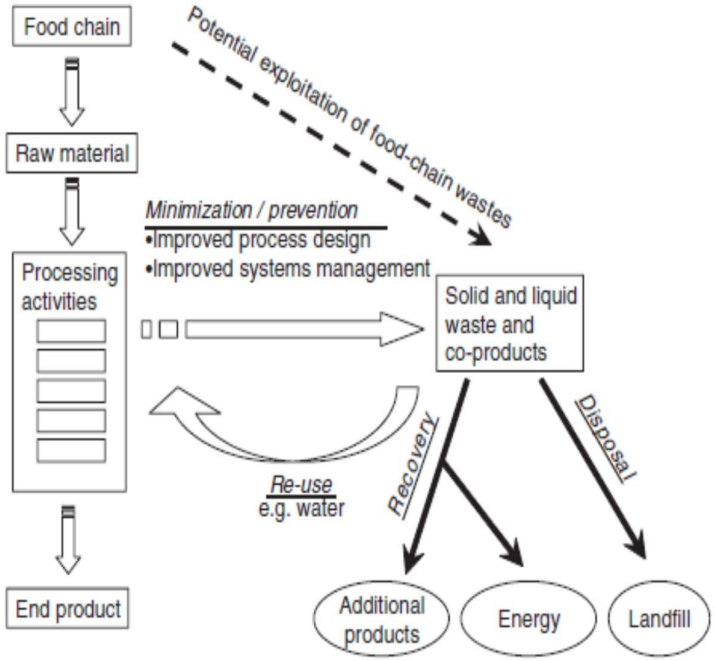

Figure 1. Food processing waste in relation to the waste hierarchy (Waldron, 2007)

This review paper provides an overview of *zero waste* and related concepts such as eco-industrial development, exploring scientific and empirical overlaps and complementarities in Serbia. The circular economy and zero waste concepts are regarded in this paper as the motivation and encouragement to guide food industry, private sectors, but public and civil organizations as well, towards zero waste practices.

A HISTORICAL OVERVIEW

Before discussion of the Zero Waste model application in current food industry in Serbia, it is necessary to look at the historical development and specifics of the food industry over the past seven decades. Namely, after World War II, large social and state-owned enterprises were established representing the main carriers of economic development due to the support of the state. The idea of the need to recycle waste or to use by-products of the food industry to create new products (e.g. persipan from apricot kernels) appeared sporadically. Large factories and companies had both, human and production capacities, and in that manner possibilities to be more active and efficient in the waste recovery. However, during this period, the level of environmental pollution was not alarming that much. On the other hand, the state strategy was to achieve the highest possible degree of industrialization. The main focus was on the volume of production and employments, while the goals of the green economy were not priorities. In the early 1990s, the disintegration of the self-governing system began, and in the period from 1990 to 2005. the most food factories cease to exist, while the surviving "giants" are mostly either in bankruptcy or in a difficult economic situation.

A CURRENT STATE

Typically, food processing creates waste. There are a variety of reasons (some economical and some technological) why so much food processing waste is being produced. Traditional food preparation results in quite small amounts of locally produced domestic waste which, especially in the past, would have been disposed of as feed, by composting or through municipal waste disposal. Nevertheless, food processing at industrial level, in particular that associated with the production of ready-to-eat meals, has created great, geographically localized waste streams which have generally raised over time (Waldron, 2007).

It is important to develop approaches that aim to utilize food by-products and waste, ensuring that all components derived in that way could be of marketable quality. This requires a research and development approach that links all the potential components in the waste stream to the potential markets available.

The challenge for food production waste utilization into higher added-value products rather than feed, fertilizers and energy has attracted the interest of researchers and industry (from our region as well) and urged the EU towards a

zero-waste economy by 2025. To this direction, recent scientific findings provide opportunities for developing eco-innovative emerging technologies for the efficient reuse of these streams leading to the recovery of new products and their recycling into the food chain (Nedovic et al., 2017).

There are many types of potentially valuable components in these wastes: nutrients and micronutrients (proteins, dietary fibers, prebiotics, antioxidants, polyphenols and other bioactive compounds), rheological agents (hydrocolloids, gelling agents, films and coatings), texturised residues, flavours and colourants (Cheunk et al., 2003; Nedovic et al., 2017). These could be exploited in pharmaceutical, cosmetic and nutraceutical high-value products, as well as food and feed ingredients.

Some of examples already investigated and proven sources of bioactive compounds isolated from agro-food waste are: pomace (raspberry, blueberry, mulberry, bilberry, cherry, sour cherry, black currant, apple, quince etc), skin and peel (grape, onion, pomegranate, red dragon fruit, citrus), seed (grape, rosehip, pumpkin) and other processing waste of olive, carrot, tomato, pepper and so on. Compounds isolated from above-mentioned sources are: oils, vitamins, phenolic compounds, colourants, flavours, fibers. Some of them are successfully incorporated in food products such as cookies, chocolate, soft drinks and sport beverages, ice cream, hazelnut paste, milk and yoghurts, fermented and cooked sausages (Kalusevic et al., 2016; Kalušević et al., 2017; Nedovic et al., 2017; Šeregelj et al., 2019; Stajic et al., 2014; Vulić et al., 2019) (Table 1).

Table 1. Utilization of byproduct/waste of agro-food industry in the food products in Serbia

Byproduct/Waste	**Active compounds**	**Implementation**	**Reference**
Black soybean seed coat	Anthocyanins	Oat meals	Kalušević, 2017.
Cherry pomace	Polyphenols, Anthocyanins	Cookies	Tumbas Šaponjac et al. 2016.
Apple pomace	Polyphenols Vitamin C Fibers	Cookies Flour Probiotic yogurts	Zlatanovic et al., 2019; Gorjanović et al., 2020; Jovanović et al., 2020.
Grape seed	Oil	Fermented sausages	Stajić et al. 2014
Pumpkin seed	Oil	Beef emulsions	Stajić et al. 2020.
Red pepper waste	Carotenoids, phenolics	Yogurts	Vulic et al. 2019; Seregelj et al. 2019.
Grape skin	Anthocyanins	Yogurts	Kalušević, 2017.
Carrot waste	Carotenoids	Yogurts	Seregelj et al., 2021.

Beetroot pomace	Betanin Polyphenols	pseudocereals-enriched einkorn water biscuits	Hidalgo et al., 2018.
Spent grain	Fibers Proteins	Snack products	Veljović et al., 2018.

Large plants in the transition period are inherited by micro, small and medium enterprises, which are mainly focused on the local markets, with limited production and with a reduced possibility of marketing products abroad. In an economical environment such this, the main goals of companies are primarily to provide a livelihood and stable working capital, while they deal with the green economy most often as part of some European projects (The European Bank for Reconstruction and Development (EBRD) and Innovation Fund Green (Innovation) Vouchers, United Nation Development Program, etc.). The lack of interest in the circular economy is partly a consequence of the inert state, which did not properly recognize the importance of this topic for food processing and society in general. The actions related to the circular functioning of the food industry remained at the level of the individual action within the local community.

Concerning above mentioned, a bottom-up model should be proposed in our country. The bottom-up model represents way where enthusiastic members of the local community should gather around a green idea, and further promote the idea with their contacts. Furthermore, from the local community, action should spread the idea until it reaches influential people or institutions that can significantly change the current picture.

Based on the results of the studies and essays done by Serbian Food Technology Council, it was concluded that over 95% of food producers in Serbia do not recycle waste. Waste/Loss is mostly already calculated in the final price, so food producers enter the linear economy without thinking about environment. In the event of a state subsidy, only 45% of respondents would be willing to make an effort in waste separation and recycling. Furthermore, only 14% would engage in the procurement of production lines that would allow them to fully utilize by-products and create a new Zero Waste production portfolio (unpublished). When it comes to small companies, a negligible number of them deal with the recycling of waste generated in the production process. However, over 90% of the surveyed SMEs are extremely careful to keep the amount of waste generated as small as possible. They achieve this in different ways depending on the type of production, starting from the selection of higher quality raw materials, through more careful processing, to the utilization of expired products.

In the fruit processing industry, the majority of the waste consists of the fruit pomace, which lags behind after squeezing the juices, and the stones and seeds, which lag behind after mashing. The pomace is mainly sold or given to cattle breeders for feeding cattle, while seeds are used as fuel due to their high caloric value. Interestingly, in food processing sector people believe that the use of seeds

as an energy source is Zero Waste technology. However, it is forgotten that Zero Waste is primarily a green idea, and the air pollution is certainly not. The use of pits as an energy source is especially present in the producers of prunes, where 98% of them use solid fuel boilers with an additional boiler for which the heating is fired with pits. The use of seeds for extraction of oil or flavor, as behind the production of persipan mass, is sporadic and it will probably take a long time for the seeds, instead of being a cheap energy source, to be used for the production of high-value products such as oil, flavor or persipan.

The fruit pomace is currently one of the major environmental problem in this sector, since significant amount of this by-product (which is currently mainly waste) is deposited during the fruit processing season (mostly apples). Since it is an easily perishable material, it begins to ferment and fastly become a source of unpleasant odors and contamination. At the moment, no large processor has an adequate solution for this problem, but mostly the pomaces are stored in piles, and only one part is taken away by cattle breeders. Pomace of fruit processing is an extremely valuable by-product, which is primarily rich in fiber and has great potential for processing into fruit flours. In the first Serbian complex agricultural cooperative "Naši voćari" from Milićevo selo (Arilje), a trial production of fruit flour was made from dried pomaces of apple, raspberry, cherry, black currant and blackberry. The production of these anti-grain flours in full capacity and commercialization is expected by the end of the year 2020.

Another way of processing is the straining of pomaces left after squeezing and the use of the obtained pulp for the production of spreads and gelled products. This practice is applied by only a few companies that deal with fruit and vegetable processing in Serbia. The resulting products may also have a nutritional statement *rich in fiber* or represent a *source of fiber*.

The largest utilization of raw materials is in the milling, bakery and confectionery industry, since there is an extremely small amount of waste that can be used further for processing. These are mostly foreign impurities (dust, stones, etc.) that do not represent environmental pollutants. Dust collects in cyclonic collectors, so it has insignificant impact on the environment. Products of inadequate quality (broken, inadequately shaped, etc.) are generally returned to processing or sold in bulk.

One of the problems identified by about 90% of bakeries is leftover pastries that were not sold during the day. Currently, this problem is solved by reducing the price of such products by about 50%, but that is not a sufficient measure, so the amount of such products is still significant. Some efforts have been made to extend the shelf life of pastries by one or two days, but that research is still in its infancy. One of the solutions may be to donate leftover pastries to centers that work with socially vulnerable categories of the population.

Furthermore, one of the serious problems is waste from the meat processing industry, since it is a perishable and potentially hazardous waste. Large companies generally have a clear waste management procedure, while the biggest problems occur with small producers and producers which are not registered for

production (unfortunately, common case in Serbia). Producers that are large have the resources and equipment to further process by-products (bone, leather, cartilage, etc.), so the amount of final waste is minimal. With smaller meat producers, the possibilities for further processing of waste are small, so there is a relatively large amount of perishable biological waste. In order to avoid paying for the removal of such waste, a significant part of small and especially unregistered meat producers dispose of waste in municipal utilities or illegal landfills, thus creating potential sources of infection.

CONCLUSION

Legislations, regulations and directives in Serbia are at the desired level and in the line with EU regulations. However, they are not sufficiently implemented still. The application of the Zero Waste principles in the food industry of Serbia is sporadic. On the other hand, there is increasing number of initiatives of individuals, associations, ministries and government sector in general. It could be expected that the number of good examples is rising, due to the planned (financial) support through various programs that are in line with Agenda 2030 as well as negotiations between Serbia and EU on the topic of Chapter 27.

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