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RECYCLING SPOILED DAIRY PRODUCTS BY EXPIRATION DATE

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Abstract: This final research report set out to find the most viable ways of using, recycling, reusing and repurposing solid waste from dairy products that had expired at the time of writing. By means of the theoretical basis, coupled with the sampling of the real scenario of products that fit this characteristic, and the results of the composition of the sample obtained, it was possible to observe that the proposed strategies have environmental viability, and need to go through longer testing phases before they can be put into practice.
Keywords: yogurt, dairy products, reuse, organic matter

INTRODUCTION

Developing ways to deal with solid waste, whether recyclable or organic, is part of a larger goal, as described in the Stockholm Declaration, 1972, "to establish a global vision and common principles to inspire and guide mankind for the preservation and improvement of the human environment" (UNEP, 1972).

Concern about waste is something that alerts today's entire food supply chain, especially perishable products. In this scenario, environmentally friendly alternatives are emerging for the use of products that are no longer fit for human consumption. Dairy products, specifically yogurts, are defined by Resolution No. 5 of November 13, 2000 of the Ministry of Agriculture and Supply as Fermented Milks, products resulting from the fermentation of pasteurized or sterilized milk by its own lactic ferments, which are fermented with cultures of proto-symbiotic Streptococcus salivarius subsp. thermophilus and Lactobacillus delbrueckii subsp. Bulgaricus

In this way, the market is developing more and more to meet the demand for yogurt on the market, as Carolina Silvestre describes, "Yogurt is among the products that Brazilians take the longest to abandon because they consider it important". This context makes sales conducive, allowing for shelves and sales areas full of yogurt in supermarkets. However, not all products displayed in supermarkets end up in consumers' homes. The expiry date shortens the shelf life of these products, and the responsibility for correctly disposing of the waste released into the supply chain lies with the supplier.

Therefore, this final report looks at viable ways of making use of the packaging and organic matter available in yogurts that have deteriorated due to their expiry date.

THEORETICAL FOUNDATION

This final research report on the recycling of spoiled dairy products due to their expiry date is based on the problem of wasted dairy products, especially yogurts, which are disposed of after their expiration date. According to the (FAO*Food and Agriculture Organization*), 1.3 billion tons of food are wasted every year, including 30% of cereals, between 40% and 50% of root crops, fruit, vegetables and oil seeds, 20% of meat and dairy products and 35% of fish. In this context, various studies and strategies have emerged on how this volume can be reduced or recycled.

As defined for solid waste in ABNT/NBR 10004:

> Solid and waste semi-solid resulting from industrial, domestic, hospital, commercial, agricultural, service and sweeping activities. This definition includes sludge from water treatment systems, those generated in pollution control equipment and installations, as well as certain liquids whose particularities make it unfeasible to discharge them into the public sewage system or bodies of water, or require solutions that are technically and economically unfeasible in view of the best available technology.

In this way, yogurt that has deteriorated due to its expiry date falls into the classification of wastesemi-solid. Shelf life is defined based on the expectation that the product will be of a certain standard within a certain period of time, preserving characteristics that meet a quality standard as described by Sivieri and Oliveira (2002), through physiological parameters, nutritional values and sensory attributes such as color, taste and texture or consistency. In this way, it can be concluded that within an average shelf life of 33.5 days (Almeida et al. 2015) and at an average temperature of 5°C, the yogurt will remain stable and with the same quality standards.

However, the current economic scenario and the development of multinational corporations drive sales growth within any sector. For Milton Friedman, "The sole purpose of a company is to generate profit for the shareholders", and this is possible by reducing costs and expenses and increasing revenues, which come from sales when it comes to the food industry.

For the sale of a product manufactured by a multinational industry to reach the consumer, there needs to be a distribution chain consisting of the industry, the distributor and the retailer, so that the end buyer can consume the product. This process consumes shelf life, so, for example, when the product has 40 days to be consumed, and it takes 12 days to reach the supermarket, there are only 28 days left for the product to be sold and consumed.

Therefore, there is a volume of products that are not sold in the supermarket until their expiration date, and these become unfit for human consumption. In this case, the products need to be removed from the shelves and disposed of correctly, but disposal generates waste of a residue that could be recycled or reused as raw material for other purposes.

Yogurts sold in retail stores are made up of packaging and product. The Minas Gerais State Environmental Foundation's Environmental Technical Guide for the Dairy Industry suggests that the packaging undergoes a process of separation from the material used, for disposal in recycling, while the industrial organic solids from the process are treated by drying, followed by disinfection using lime, so that they can be applied to the soil with the authorization of the environmental agency. This research investigated the use of organic matter from expired yogurt through two main strategies: using it in composting, or processing and drying the volume generated to be used as raw material in animal feed factories.

CONAMA Resolution No. 481 of 2017 defines composting as:

> The process of controlled biological decomposition of organic waste, carried out by a diverse population of organisms, under aerobic and conditionsthermophilic, resulting in stabilized material with properties and characteristics completely different from those that gave rise to it;

For this to occur correctly, it depends on factors such as the right temperature, humidity, pH, electrical conductivity, total nitrogen, total organic carbon and C/N ratio (Máximo, 2018). Because of the average value of 10^7 CFU/, yogurt can be considered an inoculant that accelerates the composting process. Inoculants are microorganisms added to the material to be composted in order to speed up the process (Ressetti, R. R. et al. 2020).

The use of organic yogurt waste that is unsuitable for consumption due to its shelf life as a raw material for feed after processing and drying this waste is also an alternative that deserves investigation. With regard to the use of organic waste for animal treatment, research is underway into the impact of a diet using fermented milk derivatives, due to the impact on the animal's growth and weight gain. According to research carried out by Robert E.

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Hargrove and John A. Alford, at the Nutrition and Agriculture Research Service Institute in Beltsville, USA, rats were fed various forms of fermented and acidified milk for four weeks, of which yogurt had the highest growth rate (Hargrove, Alford, 1978).

METHODOLOGY

MATERIALS AND METHODS

The research used samples of expired yogurts supplied by a distributor of refrigerated products for markets and wholesalers, which were returned to the company after they had passed their sell-by date on the shelves of the distributor's customers. The distributor's customers issue return notes and hand over the products for proper disposal.

It was also necessary to carry out a theoretical study to find out the classification of the waste generated in the situation, and what are the ecologically correct alternatives for reusing this waste through a bibliographical review of the available content. Studies on the composition of yogurts and their microbiological richness were also necessary.

In addition, it was necessary to sample the total universe of products that returned expired to the distributor through a report containing the total yogurts received by return note regarding deterioration by expiration date, which constituted nine thousand kilos in the period from January to June 2022, and from the report the percentage of each product that makes up the total universe of products was obtained, so that it was possible to take a sample of 1kg with the proportions equal to the total. We also needed a precision scale and an aseptic plastic bag to take the sample.

Finally, the report underwent laboratory analysis in partnership with Terranálises of Fraiburgo.

RESEARCH STAGES

A theoretical basis was used to find useful alternatives for the organic matter in yogurt that had deteriorated due to its expiry date. The process required the search for the correct classification of the waste as non-hazardous, non-inert solid waste (ABNT NBR 10004). The conventionally used ways of disposing of this waste is through disposal in a landfill built on a waterproof base so as not to cause leakage into the soil and contamination with substancesphytotoxic. Ecologically correct alternatives have also been found, such as reuse by dumping the dry, lime-treated waste in the soil.

A sample of 1 kg was then taken from the total return report considered by the distributor during the first six months of 2022 (January, February, March, April, May and June) to create a sample that could represent the universe of products returned within that given period. This was necessary in order to consolidate the volumes sold, with the new products marketed that had probiotics added to their formulation.

At the same time as this process, more theoretical research was carried out to understand which of the two mechanisms was more economically viable, and which would have a better prospect of being used. In this situation, almost no referenced articles were found dealing with the destination for animal feed.

The sample was sent for analysis to a third-party laboratory, which carried out the analysis based on the Manuals and MethodsBromatology, by Freitag Laboratories, and Methods of Bromatological Food Analysis: Physical, Chemical and Bromatological Methods by Embrapa. The result suggested a high moisture, fat, sodium and carbohydrate content. On the other hand, both destinations suggested drying the residue to make better use of it.

RESULTS AND DISCUSSION OF RESULTS

The main result obtained from the research was the composition of the sample of dairy products spoiled by expiry dates. This composition is described in Annex 1 and Annex 2, and shows which substances and chemical components are positive or negative for the destinations studied.

It was also possible to find out what ways are already known of using this organic material from yogurt that has deteriorated due to its expiry date, and to understand what the market, environmental, political, economic and geographical impediments and facilitators are.

Despite this, the research time was not sufficient to objectify the results obtained, beyond the substances contained in the sample indicated.

ANNEX 1

RESULTS							
PARAMETER	**RESULT**	**UNIT**	**LQ**	**LD**	**U95%**	**METHOD**	**DATE TESTS**
Total sugars (L[5])	11,01	g/100mL	-	-	-	Freitag Laboratories, Methods Manual Bromatology 2021. Chap.15	28/03/2023
Determination of Total Carbohydrates (L[5])	11,01	g/100g	-	-	-	Freitag Laboratories, Methods Manual Bromatology 2021. Chap.15	28/03/2023

Caption:
LQ - Limit of Quantification.

LD - Limit of detection.

U95% - Expanded uncertainty reported is based on a combined uncertainty, multiplied by a span factor K, for a confidence level of approximately 95%.

VMP - Maximum Permitted Value.

Notes:
Note 01: The results refer only to the sample analyzed.

Note 02: This test report only may be reproduced in full.

Note 03: (Ln) Service from external provider.

Note 04: The opinions and interpretations of the results expressed are outside the scope of this laboratory's accreditation.

Note 05: When the sampling is carried out by the contractor, the Laboratory Terranálises is responsible for the test results from the moment the samples enter the laboratory and the Accreditation seal is applied exclusively to the tests carried out and described on the page containing the seal.

ANNEX 2

Protocol	SAMPLE DATA						
	Registration	**Culture**	**Collector**	**Date of Collection**	**Collection point**	**Depth (cm)**	**Area (ha)**
S.3172.2023.Bro.1.1	NOT INFO	NOT INFO	vide(1)	NOT INFO	-	NOT INFO	NOT INFO

Sample	Ethereal Extract g/Kg	Crude fiber %	Mineral Matter	Total Digestible Nutrients (NDT) %	Crude Protein %	Humidity 65ºC %	Phosphorus g/Kg	Potassium g/Kg	Organic matter %	Calcium g/Kg
S.3172.2023. Bro.1.1	208,7	15,64	95,93	74,75	14,61	84,02	2,93	62,45	5,43	4,60

Sample	Magnesium g/Kg	Iron mg/Kg	Manganese mg/Kg	Sodium mg/Kg	Copper mg/Kg	Zinc mg/Kg	Boron g/Kg	Sulphur g/Kg	Total nitrogen %
S.3172.2023. Bro.1.1	<0,15	18,59	<0,50	933,2	2,19	9,80	<0,15	60,54	23,38

CONCLUSIONS AND PROSPECTS FOR FUTURE WORK

At the end of this report, it is possible to conclude that there is a need to study this aspect, in order to improve the known ways of correctly disposing of yogurt that has deteriorated due to its expiry date, as well as the wealth of opportunities that this current sector encompasses.

Consequently, there is a window of opportunity for further research into the use of organic compost from expired yogurt for animal feed. As it is a product rich in microorganisms, macronutrients, micronutrients and moisture, there is a clear need for further research. It is important to take into account the use of compost for composting. Because of its richness, soils can benefit from the fertilizer produced by composting this solid organic waste.

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