ТЕХНИЧЕСКИЕ НАУКИ

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EFFECTS OF WASHING PRE-TREATMENT WITH HOT WATER ON DRYING PROCESS OF FOOD WASTE

The study aims to determine the effects of pre-treatment and temperature on the drying behavior of food waste. The collected food waste was pre-treated by soaking in warm distilled water at 50°C for 10 minutes before the hot air-drying process at 70°C and 85°C. A hot air dryer at different drying times and temperatures were used to measure the food waste until no noticeable weight loss. In the beginning, the moisture content fell quickly, and then progressively decreased with increasing drying time. Food waste at 85°C recorded the shortest drying time of 121 minutes to reach equilibrium compared to another drying parameter 70 °C. The equilibrium moisture content of pre-treated food waste with hot distilled water at a temperature of 70 ˚C was 0.609g H_2O g^{-1} dry solid since the non-pre-treated food waste was 0.767 g H_2O g^{-1} dry solid. The equilibrium moisture content of pre-treated food waste at 85˚C was 0.489 g H_2O g^{-1} dry solid. In conclusion, washing pretreatment has a significant impact on the drying process because pretreated samples reach equilibrium faster than non-washed ones. Overall, Drying technologies are essential for reducing the moisture content of food waste, which is required for environmental sustainability and safety.

Key words: *Food Waste, Hot Air Drying, equilibrium moisture content.*

1. INTRODUCTION

Global waste generation keeps increasing over the years, Food waste recycling is a critical waste management issue in the recycling industry [1]. Since food waste is so rich in organic matter, it can serve as a special kind of composting. Food waste may contain synthetic preservation chemicals, but this will not stop it from being a useful bio-composting material. Additionally, bio-composting is one method that can be used to lessen the amount of food waste that accumulates in most nations [2]. One of the main environmental impacts of food waste is related to its final disposal in landfills. This may lead to the carbon footprint of food waste as carbon dioxide generation. High moisture content can speed up the decomposition of organic waste, as well as increase leachate flux and pollutant emissions [3].

The loss or removal of water from the food waste and the source of household organic matter is viewed as an emergent alternative to processing food waste since it is obtained from 75 % to 95 % by weight from this fraction of the waste. The elimination of extra moisture from the source by drying greatly decreases the waste content and waste volume in the kitchen. The low water content of food waste prevents the process of biological compounds, reduces odor emissions, and decreases the collection frequency of food waste. It can be handled much more easily [5]. Food waste collection and recycling is a major concern in waste management. Because moisture content must be kept low in organic compounds to prevent the growth of bacteria [4]. Dehydration is a viable alternative to the currently used food waste management methods, such as direct composting and anaerobic digestion.

2. EXPERIMENTAL

In this study, food waste as shown in Figure 1 is subjected to hot air drying. The collected samples were pre-treated for ten minutes with distilled hot water at 50^0C. Pre-treated and non-pre-treated food waste was dried at different two different temperatures (70 and 80) ^{0}C. The study aims to examine the impacts of pre-treatment on drying kinetics, and the influence of dry food waste in the final product to reduce environmental pollution.

Figure 1. Collated community food waste

2.1 Moisture Content

Food waste was retrieved periodically from the drying tray and weighed. Moisture content (MC_{db}) on a dry basis was determined periodically based on the weight of the drying samples according to Equation (1) [6]. And normalized in Excel using the series function [7].

$$MCdb = \frac{M_i - M_{db}}{M_{bd}} \times 100 (g\ H_2O\ g^{-1}\ dry\ solid) \quad (1)$$

2.2 Drying Rates

The drying rate is obtained by the slope of moisture removal tangents at dt [8][9] Equation (2).

$$\frac{dX_i}{d_t} = -\frac{Mi - M_{i+1}}{t_i - t_{i+1}} (gH_2O\ per\ m^2 / min) \quad (2)$$

$\frac{dX_i}{d_t}$ shows the drying rate, the drying rate,

$\frac{dX_i}{d_t}$ is expressed in g H_2O per square meter per minute.

2.3 Moisture Content

The equilibrium moisture content(EMC) of food waste is determined by using equation (3) [6].

$$X_e = \frac{M_i - M_{bd}}{M_{bd}} \tag{3}$$

Where *Mi* is the final net weight, M_{bd} is the bone drying value.

3. RESULT AND DISCUSSION

A hot air dryer was used to measure food waste at 70 and 85°C until no noticeable weight loss was detected. Table 1 and Figure 2 show the total drying time for food waste. Initially, the moisture content dropped rapidly, then gradually decreased with drying time. The higher drying temperatures result in faster drying times. Increased drying temperature will eventually speed up the drying process by increasing the drying rate. In particular, hot air drying at 85 °C was the shortest drying time 121 minutes took to reach equilibrium compared to 70°C. As the temperature rises, the drying rate also increases, especially in the initial phase of the drying process. A more significant difference in temperature between the air and the material's surface encourages moisture transport. Heat transfer and drying time can be sped up by increasing air temperature [10].

Table 1

Time required for food waste to achieve the equilibrium moisture content

Temperature (°C)	Pre-treatment	Drying Time (minutes)	Equilibrium Moisture Content (g $H2O\ g^{-1}$ dry solid)
70	Pretreated Food waste	140	0.609
	Non-Pretreated Food waste	180	0.767
85	Pretreated Food waste	121	0.489
	Non-Pretreated Food waste	150	0.578

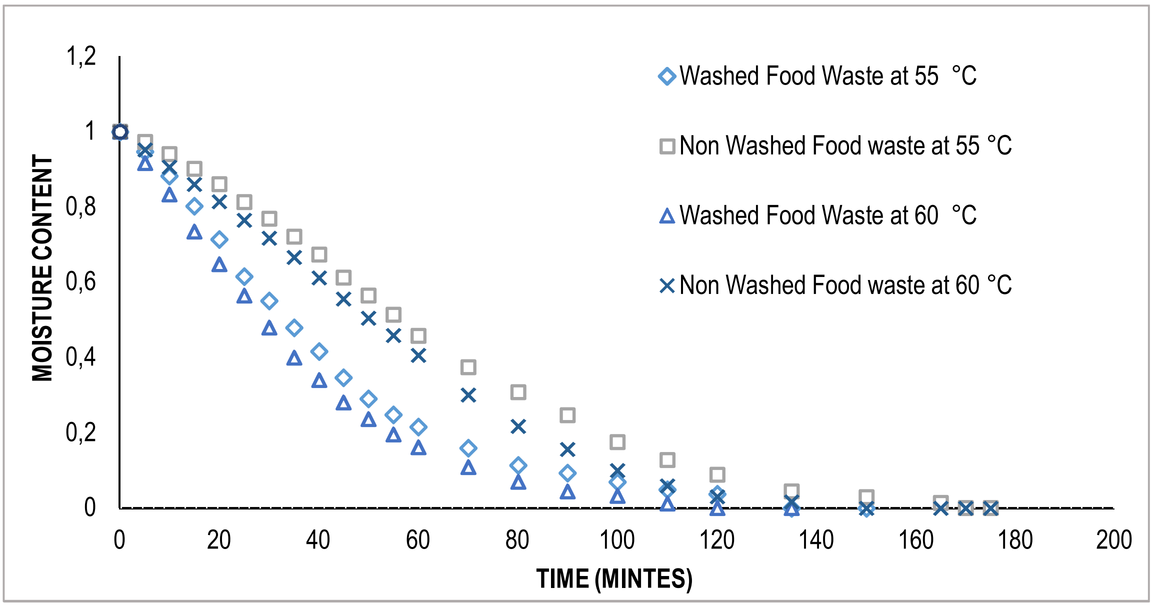

Figure 2. Required time for food waste to achieve the equilibrium moisture content

According to Figure 2 air temperature and pre-treatment had a major effect on the dehydration rate of food waste. After treatment, the drying time decreased significantly. Soaking food waste in distilled hot water for ten minutes reduces the drying time of the samples. Due to the pre-treatment of the samples with hot water before drying, the impurities like oil, salt, and dust were removed from the surface, increasing the evaporation process. To expedite the sublimation process, it is required to pre-treat the materials before drying. Because pre-treatment properties allow the moisture to escape into the atmosphere more quickly [11]. Suitable pre-treatments can drastically decrease the basic moisture content of the material or alter its characteristics, increasing the drying rate and thus the material's quality; and inhibit bio-enzymes, thereby decreasing breakdown processes during drying and subsequent storage [12]. When using food waste as a raw material for compost, biogas, or thermal energy, it is necessary to dehydrate it, since dry crops handle it more effectively than wet organic waste which can reduce environmental contamination.

4. CONCLUSION

The present research on the drying kinetics of food waste helps us understand moisture transfer pathways better. Evaluating drying process features such as humidity diffusion and drying energy simulation can aid in empirically estimating the drying rate. Dry crops also handle food waste better than wet crops and can provide sustainable materials such as biogas, thermal energy, and compost. Because of the zero environmental impact and reduced carbon footprint, this study recommended that organic waste be dried before composting. The moisture content, on the other hand, must be constantly controlled until it reaches the appropriate level for composting.

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ВЛИЯНИЕ ПРЕДВАРИТЕЛЬНОЙ ПРОМЫВКИ ГОРЯЧЕЙ ВОДОЙ НА ПРОЦЕСС СУШКИ ПИЩЕВЫХ ОТХОДОВ

Исследование направлено на определение влияния предварительной промывкой и воздействием температур на поведение пищевых отходов при сушке. Собранные пищевые отходы предварительно обрабатывали путем замачивания в теплой дистиллированной воде при 50°С в течение 10 минут перед процессом сушки горячим воздухом при 70°С и 85°С. Для измерения пищевых отходов использовали сушилку с горячим воздухом при различном времени сушки и температуре до тех пор, пока не наблюдалось заметной потери веса. Вначале содержание влаги быстро падало, а затем постепенно уменьшалось с увеличением времени сушки. Пищевые отходы при температуре 85°С показали самое короткое время сушки, составляющее 121 минуту, для достижения равновесия по сравнению с другим параметром сушки при 70°С. Равновесная влажность предварительно обработанных пищевых отходов горячей дистиллированной водой при температуре 70°С составила 0,609 г H2O г-1 сухого вещества, тогда как необработанные пищевые отходы содержали 0,767 г H2O г-1 сухого вещества. Равновесное содержание влаги в предварительно обработанных пищевых отходах при 85°С составляло 0,489 г H2O г-1 сухого вещества. Таким образом, предварительная промывка оказывает значительное влияние на процесс сушки, поскольку предварительно обработанные образцы достигают равновесия быстрее, чем непромытые. В целом, технологии сушки необходимы для снижения содержания влаги в пищевых отходах, что необходимо для экологической устойчивости и безопасности.

Ключевые слова: *пищевые отходы, сушка горячим воздухом, равновесная влажность.*