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HOSPITALITY AND BUSINESSSUB-THEMEPAPERS

Eco-Plate as a Sustainable Alternative to Single-Use Plastics in Food Service industry

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ABSTRACT

Plastic containers are widely used in households and industries. This is because their production cost are relatively low, they can easily be moulded in to any shape and they are resistant to corrosion. Across the world, single-use plastic tableware is common in food service operations because it offers the much desired convenience. However, their use and subsequent disposal aggravates the challenge of solid waste in the environment. In particular, the continued production and use of plastics is associated with greenhouse gas emissions, health complications, provide breeding grounds for disease vectors, clog sewer systems, reduce aesthetic value of ecosystems and related environmental pollution because they are not biodegradable. Globally, there has been a growing concern on the menace caused by plastics on the environment. In realising the dangers of continued plastic use, efforts have been directed towards development of sustainable alternatives. To this end, stakeholders in the hospitality industry have been developing and adopting eco-friendly technologies and practices. Consequently, this paper discusses the development and use of an edible and abiodegradableplate(eco-plate). This eco-plateismadefromplant-based dough whose main ingredients are red sorghum flour, wheat flour and margarine. Five groups of eco-plates (A, B, C, D and E) were made from doughs of different ratios of red sorghum flour, wheat flour and margarine (2:2:1, 3:2:1, 2:3:1, 1:2:0.5 and 1:1:0). These five classes of eco-plates were tested

for organoleptic properties, water absorption capacity and biodegradability. Eco-plate C was considered the most acceptable eco-plate by more than three quarters (77%) of their spondents who tasted the samples. This make of eco-plate had the highest absorption capacity (33%)due to increased gluten from wheat flour. All the makes of eco-plates decomposed within six days. This implies that the adoption ofeco-plateinfoodserviceoperationswillgreatlyreduceenvironmentaldegradationassociatedwithuseandproductionofplastics.

Keywords*: Bio-degradable tableware, climate action, plastic pollution, sustainable tourism and hospitality, waste management*

INTRODUCTION

Food service industry encompasses establishments which prepare and serve meals to people for on-premises or off-premises consumption. They include full-service restaurants, fast-food outlets, caterers and cafeterias. Theindustryisone of the largest and fastest-growing economic activities, in many countries across the world. Globally, the industry had a market size of USD 2,395.03 billion in 2022 and is projected to increase to USD 5,423.59 billion by 2030(Fortune Business Insights, 2023). Food service industry is considered a vital contributor of economic developmentas it offers sundry benefits. For instance, food service industry contributed 7.02% of Indonesian GDP in 2020(Srimulyani & Hermanto, 2022). In 2021, the industry employed more than 4.1 million people in the US (US BureauofLabour Statistics,2023). In India, over 7 million job opportunities were generated in food serviceindustryin2021, despitehavinglostabout2millionjobsduringCovid-19outbreak(Keelery,2023).About 13%ofSouthAfrica'sGDPwasgeneratedfromfast-foodsectoralonein2018,excludingotherfoodserviceestablishments(Habanabakize,2020).

Traditionally, food service establishment used to target people who were away from home but because of convenience, people have widely embraced use of food delivery services who deliver food at customers' convenient places. Additionally, in today's fast-paced world, morepeople prefer and appreciate the convenience of having meals on-the-go. These new trends are mainly due to a growing middle class which is driving increased consumption above subsistence levels and rapid urbanization. Projections by Yueh (2013) show that the global middle class will grow to

4.9 billion by 2030 up from 3.2 billion which was projected for 2020. People living an urban lifestyle have a high preference for takeout and home delivered meals which are quick, simple, affordable and hassle-free. Fast-paced, on-the-go kind of a lifestyle that is synonymous with urban centres makes convenience very appealing. One packagingmaterialthatoffersconvenienceduetoitsexcellentmechanical,processingandchemicalstabilitypropertiesisplastic.Plastic bags, straws, takeout cutlery, and plastic food packaging are the most common plastics used in food service(Walker et al., 2021). It is estimated that, by 2050, 7 out of 10 people are

likely to be living in urban areas (UnitedNations,2022).From the developmentst and point ,this projection is good news since cities and metropolises are

centres of business activity and economic growth. On the flip side, increased urbanization accelerates generation of plastic waste from food service (Phelan *et al.,* 2021).

Plastics used in food service are intended for single-use and usually used for short-lived products hence, they have high littering rates. Due to prevalent use of plastic food packaging, plastic pollution has turned out to be a global menace. A report by UNESCO showed that hotel industry is a major contributor to plastic pollution whereby it produces over 150 million tons of single-use plastic, annually (Ella, 2022). Despite the wide use of plastics, their use is associated with significant environmental pollution. This is what motivated a resolve by the United Nations Environmental Assembly in 2022 calling for development of stricter laws on use of plastics (UNEP, 2023).

This global concern is a wake-up call for governments, hospitality industry and stakeholders to starting getting in to action. Some notable efforts by different governments in regard to this include countries like China, India and Ireland and countries in the Southern African Development Community (SADC) region which have developed policies on single-use plastic bags Clayton et al. (2020) note that single-use plastic regulations are more active in developing countries than in industrialized countries. Furthermore, Africa leads in implementation of plastic bags policies (Nwafor & Walker, 2020).

On a daily basis, approximately 30 truckloads of plastic packaging are dumped in the environment (UN, 2022). In Nairobi's Dandoral and fill, much of the waste dumbed there is plastic. The Kenyan government, through the National Environmental Authority(NEMA)has continued to put significant efforts in containing plastic pollution. For example, a ban on manufacture and use of single-use plastics has been in effect since 2017 (Andae, 2023). Replacement of single-use plastics with substitute materials like paper and compostable materials could decrease plastic pollution by17% (UNEP, 2023a). In addition, governments also allocate funds for development of waste management facilities such as recycling, landfills and incineration units. However, there is need for a more efficient way of not only handling waste associated with plastics, but reducing their use as well (Goutam *et al.,* 2021).

The continued wide use of plastics has caused not only environmental pollution but also health problems to humans and animals. The growing hospitality sector is a great user of plastics. However, with increasing sensitization on environmental consciousness, there have been efforts by establishments and stakeholders in the hospitality

industrytoincludeenvironmentalconservationintheirbusinessmodel.Forinstance,somehospitalityentrepreneursoffereco-friendlyproductsthrough“reuse,recycleandreduceofwaste”strategies.Suchstrategiesnotonlyimproveonenvironmentalconservation,butitalsoincreasestheprofitmarginsfortheseestablishments.Reducing or replacing plastics with tableware (plates, cups and spoons) made from biodegradable and edible materials would possess confer multiple benefits. Therefore, this project aimed providing aprototype single-use plate which is made from sorghum and wheat flours.

MATERIALSAND METHOD

Raw Materials

The raw materials for Eco-plate were acquired locally with the aim of promoting economic sustainability of the local residents. Wheat flour, margarine, salt and sugar were bought from a local supermarket in Tharaka NithiCounty. Red sorghum was procured from a local market and milled. Red sorghum was preferred as one of the main ingredientsbecauseitisdroughtresistantandlargelygrowninTharakaNithi County and the neighboring counties. Besides, use of sorghum in food products is very limited and it has a fairly good colour and nutritional content compared to rice and maize. Wheat flour was used because it is rich in gluten, a natural glue that lacks in sorghum flour. Margarine was used to aid in improving flavour and texture of the product while salt and sugar was used to add taste.

Preparation of Eco-plate

Fivedistinctsamplesweremadeusingdifferentratiosofredsorghumflour, wheat flour and margarine. The ratios for samples A, B, C, D and E are shown on Table 1. During preparation, all ingredients for each sample were combined and adequate amount of salt and sugar to give taste. Thenwaterwasaddedandthemixturewaskneadedintoasmoothdough.Thedoughwasallowedtorestfor30minutesinordertoallowforstarchtoabsorbwater.Afterthat, the dough was rolled into thin sheets big enough to line the plate moulds. The thin sheets of dough were then placed over then on-stick plate moulds .Aparchment paper was then placed over the dough and filled with uncooked dried beans .The weight of the beans prevented the dough base from rising during baking. The dough was blind baked in a preheatedovenfor30minutesat170^{0}Celsius.Afterbakingfor30minutes ,the dried beans and the parchment paper were

removed and the dough allowed to bake for a further 5 to 10 minutes until crispy. Theplates were allowed to cool before tests were carried out.

Table1: FormulationoftheSamples

Ingredients	SampleA	SampleB	SampleC	SampleD	SampleE
Redsorghumflour	500g	750g	500g	500g	250g
Wheat flour	500g	500g	750g	250g	250g
Margarine	250g	250g	250g	125g	0g
Salt	To taste	To taste	To taste	To taste	To taste
Sugar	To taste	To taste	To taste	To taste	To taste

Figure 1: Eco-plates made from Varying Proportions of Ingredients

RESULTSANDDISCUSSIONS

Organoleptic Evaluation

Organoleptic properties of the samples were appraised based on their texture, colour, smell, taste and over allacceptability (Sood & Deepshika, 2018). Thirty individuals were randomly selected and briefed on key points to note before being served with pieces of the three samples. They then rated the organoleptic parameter scores for each sample on a nine-point hedonic scale. The points ranged from '1-dislike extremely' to '9-like extremely' with 5 as a neutral point 'neither like nor dislike'.

The recorded scores for respective parameters were compiled and average scores calculated (Figure 2). The scores revealed that Sample E was least preferred by the panelists with majority of the organoleptic parameters rating being way below 6.0. This was attributed to lack of shortening agent (margarine) in its dough mixture which caused the product to be less flaky and hard to chew. Notably, the scores for color of all samples showed minute variation. This might have been due to presence of the rich natural colour of red sorghum flour which dominated the final look of all products. All organoleptic parameters scores for samples A and C were above 6.0, which were higher, compared to other samples in the study. The two samples had equal amounts of red sorghum flour and margarine in their dough mixtures. However, sample C had a higher amount of wheat flour and its rating for smell and taste was higher compared to those of sample A. Additionally, more than 77% of the team of panellists ranked sample C as the most preferable garnering a score of 6.97 on its overall acceptability. These findings corroborated those of edible cutleries developed by Thagunna et al. (2023) and Iqbal et al. (2022).

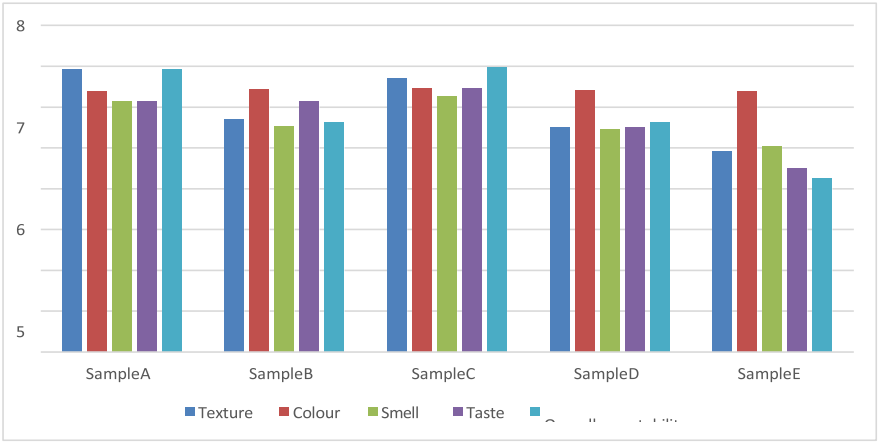

Figure2: Organoleptic Assessment of the Different Make sofEco-plates

Water Absorption Capacity

Water absorption capacity (WAC) was measured by a modification of the method used by Shrestha and Srivastava(2017). Considering the density of wateris1g/ml, pieces off our replicas of each sample were weighed and immersed in cold water. Thesampleswereta kenoutofthewaterafter5minutes intervals, excess surface water wiped away and the samples were weighed. This was repeated until the samples became soggy. The WAC for each sample was determined by calculating an average of the four replicas .The same procedure was repeated using hot water to simulate cold and hot liquid foods respectively. The following formula was used to determine water absorption capacity;

$$WAC(\%)=\frac{\text{Weight of water absorbed(g)}}{\text{Weight of the sample (g)}}\times 100$$

Allthesampleswereimmersedinwaterforthesamedurationoftime.SampleEwhichdidnotcontainanyshortening agent, absorbed less amount of water (18.32%) at the end of the 20 minutes' experiment (see Figure 3). Moreover, sample E did not become soggy as quickly as other samples did. Shortening agents such as margarine, break down gluten strands present in wheat flour and make baked products have a crumbly structure. In this case, sample E had a solid structure which could not permeate water easily. On the contrary, despite sample C containing some margarine, it had a water absorption capacity of 33.27%. This observation could be explained by the increased amount of wheat flour in the sample mixture which improved its ingredients adhesiveness thereby maintaining the structure of the product even when it continued to absorb water. Wheat flour is capable of forming gluten networks and building starch-water bonds that retain moisture well (Iqbal *etal.,*2022). On account of this, sample Chaving the highest water holding capacity. The WAC percentages were closely related to the ones shown on Figure 3, when the test was repeated using hot water. The reason for this observation is due to reduced strength of dough gluten formation caused by heat in the water (Mann *et al.,* 2014).

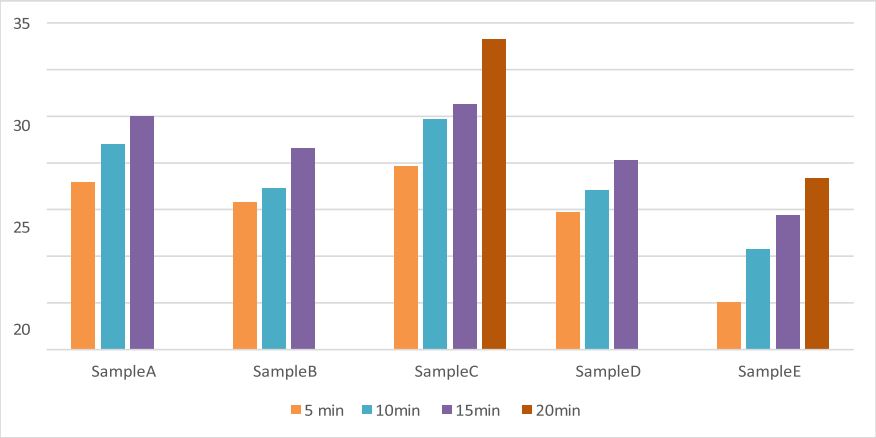

Figure 3: Water Absorption Capacity of Different Eco-Plates Over Time

Biodegradability Test

Asoilburialtest was used to test biodegradability of the samples. Pieces of the samples were buried in sterile soil and observations for gradual decomposition were made on daily basis (Dordevic *et al.,* 2021). The number of days each sample took to biodegrade while buried in the soil was recorded. Biodegradation for all samples was comparable. Each sample gradually disintegrated in to smaller bits between day3 and day4. All the sample deco-platesdecomposedwithin6days.WhentheprocessofEco-platedecompositioniscomparedtothatofchemicallymodifiedbiodegradablepolymers, the process is easy since the product is made from natural ingredients. However, natural breakdown of chemically modified biodegradable polymer is a laborious procedure (Leja & Lewandowicz, 2010).

CONCLUSIONS

Thereisanurgentneedtoaddresstheproblemofplasticpollutionusingsustainablesolutions.Edibletablewarei sonestrategy that can be used as a response to plastic menace. The eco-friendly plate that was developed in this study is suitable sustainable alternative to disposable plastic plates used in food service industry because of several reasons. The process of making Eco-plate is easy and its raw materials are natural and locally available therefore, it will help meet economic expectation so fits manufacturers. The product is also edible and nutritious thus, can beaten by human beings or animals. Eco-plate also takes 6 days to decompose naturally hence, it can be disposed in a compost pit or land fills thereby enriching the soil without any negative impact on the environment. Therefore, the product developed here in could help to reduce the production of single-use plastics and consequently reduce environmental pollution.

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