

Baking, Local Dry Heat Mud Ovens, and Appropriate Technology: Implications for Social Change in Sierra Leone

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Abstract: A descriptive qualitative case study methodology was deployed to explore baking as a method of cooking and dry heat ovens in Sierra Leonean. The study was a project to partially fulfill the requirements for the award of an associate degree in food science at Njala University College, University of Sierra Leone. The study focused on baking using low-cost, dry heat, efficient ovens as an income-generating enterprise, highlighting the challenges faced by local bakers, and alleviation strategies to help bring about social change in Sierra Leone. Data collection and analysis included content analysis of articles, interviews with community members, observations, and hands-on participation. The Social Enterprise Theory, Appropriate Technology, and Heat Transfer concepts were the conceptual frameworks that guided the study. Meta-analysis of articles and interviews of participants yielded themes or phrases such as food, economic benefit, land, labor, prices, ingredients, satisfaction, and career. These themes were part of the coding and analysis that facilitated discussions regarding baking as a social enterprise, its health and economic benefits, challenges faced by local bakers within the community, and an in-depth understanding of the phenomenon. Results indicated that the use of dry heat oven for baking were easy to prepare with low-cost materials and are capable of functioning efficiently. Furthermore, results indicated that many bakers would prefer baking as a career but are hindered by financing options and would need help as they could not meet microfinancing requirements. Baking has a great potential for communities in Sierra Leone for social entrepreneurship and illuminates appropriate technology in contributing to social change in Sierra Leone. The current global economic crisis was also a critical factor impacting bakers as the prices of supplies and cost of production have doubled.

Keywords: Baking, Dry Heat Ovens, Food Science, Appropriate Technology, Oven Designs, Social Change.

I. INTRODUCTION

Baking is one of the most common and oldest forms of food processing known to man (Baking, 2020). The art of baking involves the cooking of food with dry heat (*The American Heritage Roget's Thesaurus*, 2014). Several thousand years ago, the use of heat sources for baking food evolved from primitive methodologies like hot rocks or hot ashes to modern-day ovens. In baking, heat slowly travels through the dough of the bread, cooking it into a soft baked material with an exterior crust (Baking, 2020). Baking enhances the taste of food materials compared to their original nature, which gives a different taste and texture often not appealing to many people.

Throughout history, man has been relentless in pursuing technology to improve lives and provide comfort. We have seen nations develop rapidly over the last several decades, influenced by technology and the willingness of people to engage in developmental activities. Some nations have developed rapidly, while others lagged partly because of politics, economic parity, mismanagement of leadership, and lack of foresight.

The article explores dry heat ovens and baking within the context of appropriate technology. Specifically, the study focuses on low-cost, efficient earth oven designs and process of heat generation, baking methodologies, and the health and economic benefits of using dry heat ovens for baking. Furthermore, the study examines the challenges faced by bakers within the community and strategies to help alleviate some of those barriers.

To achieve our goal, we searched academic journals, artifacts, related textbooks and news materials, and local expert knowledge for dry heat oven manufacture, preparation, and maintenance in Sierra Leone. We by no means claim an exhaustive account of the phenomenon under study. Rather, we provide what is already known in literature and with the findings of this study, we attempt to help bridge the gap in knowledge regarding dry heat ovens as heat source for baking in Sierra Leone. There little or no literature available in academia regarding the use of dry heat ovens and baking in the Sierra Leonean context unlike other countries, even though the practice is common within our communities.

Background to the Study

With the current global economic crisis, the need for appropriate technology and self-reliance must be the driving force for survival for many developing countries. The war in Ukraine impacted many countries in terms of food supply and energy. Many African countries have experienced tremendous setback in local food production, imports of food supplies, and energy shortages, partly because of the war and other logistical difficulties. Some of these countries rely on imports of grains from Ukraine and other parts of the world. The conflict has caused delays in accessing essential goods and services, and has impacted global trade and business, as well as local enterprises. The World Bank's latest update on global economic issues was that domestic food prices and inflation remains high around the world, especially in almost all low-income and middle-income countries, with many experiencing double-digit inflation (World Bank, 2022). These global developments call for a fierce urgency in self-reliance, self-determination, and self-empowerment for African nations.

Up to the late 1940s to early 1950s, Sierra Leone has moved from self-sufficiency in food security to reliance on imports even in its staple food – rice. The World Food Program reported that "around 5.1 million Sierra Leoneans are estimated to lack sufficient nutritious food to live a healthy life, with 789,536 being severely food insecure" (WFP, 2020). Sierra Leoneans must deploy strategies to empower themselves for their own good rather than relying on government to provide jobs and livelihood for the vast population. Baking provides opportunities in the area of social entrepreneurship. There are professional bakers in the country that are doing well and have less to worry about in terms food security and income. According to industry reports, in the United States, the annual revenue for the retail bakery industry is over \$3 billion, and in the small commercial bakery industry it is around \$7.5 billion (Profit Venture, 2022). Although thoughts have not been given to effectively track the economic contribution of bakery in Sierra Leone, it is clear that those engaged in the bakery industry show signs of self-sufficiency, profitability, rest of mind, good health, and are able to meet with other obligations of life. By engaging in bakery services and extensive entrepreneurship, many young adults seeking job opportunities may find relief. Many high school and university graduates are searching for jobs and need economic empowerment, growth, and must help to contribute their quota to social responsibility and change in Sierra Leone. Unfortunately, few graduates show interest in what they refer to as "low class careers" and would rather wait for office jobs that are not forthcoming.

The current economic trend in Sierra Leone and other African countries show no sign of easing to facilitate faster economic growth and entrepreneurship. Kamara (2019) found that youth entrepreneurs are unaware of the extensive resources at their disposal. Kamara (2019) suggested that these young adults must be educated and organized into groups like "young entrepreneurs of the future" and learn to make use of appropriate technology. The myth is that huge capital must be available to start a business and without a specified huge capital, business is not worth it. This myth has been debunked as we see petty traders in the marketplaces make their daily living via the sale of simple products like pepper, onions, salt, potato and cassava leaves and have no time to grumble about "hard times" in the country. Unlike our young adults seen around cities seeking jobs that do not match their credentials. For example, a university graduate in the linguistics discipline seeks and office job. The question one would ask is "Who will hire a candidate for an office job with a qualification in linguistics or literature in Sierra Leone? Yet, these graduates overlook social enterprises like baking and other culinary businesses.

In the last two decades, Sierra Leone have experienced extensive migration from the interior districts to the capital city. This forced migration couple with voluntary movement of persons in search for opportunities, resulted in the abandoning of farmlands and other local business initiatives around villages. However, there are a significant sector of the population in Sierra Leone who are entrepreneurship-minded individuals investing in income-generating activities like baking, oven manufacturing, tool making, farming, poultry, and apprenticeships in other trades on a very small scale. Furthermore, the educational sector in Sierra Leone is focusing on vocational disciplines through the curriculum of schools, colleges, and universities to help develop the workforce. There are several productive initiatives such as the government's microfinancing, schools and universities programs, nongovernmental organization projects, and individual efforts are testaments to a positive shift in thinking, but still not enough to create impact on the country. Unfortunately, most of the younger generations have no interest in developing some of these income-generating skills. They prefer office jobs that are not forthcoming and have little to do with their educational disciplines. The younger generation pay no attention to what is outside of their immediate needs but yield intensely towards styles and flamboyance (Researchomatic, 2012). They have no interest in what they refer to as "low-class income generating jobs" or businesses.

It is documented that culinary services provide a way out of idleness, poverty, and desperation, and provides hope for many families. ECPI university programs advanced 12 reasons why students should invest in a degree in bakery and pastry arts. Some of these reasons include hands-on-mentoring, immediate gratification or feedback on investment, business with pleasure, open potluck invitations, flexible schedules, product specialization and creativity, sustainable market, high potential for growth, and a loyal customer base. Furthermore, many people baking have used baking as an antidote to stress (Best Baking Tips, n.d.), while others have done baking to effect social change within their communities (Shoukas, 2014). For example, the Hot Bread Kitchen is an East Harlem baking cooperative in the United States which began with a training program to create new careers for women from all over the world. They later went on to launch a kitchen incubator program to help food companies throughout New York City (Shoukas, 2014). With this initiate, they were able to help restaurants greatly in food preservation and preparation, thus contributing to social change. This is a typical example of how baking and other culinary services could be contributors to social change and should not be overlooked.

Baking is a source of motivation for many children around the world. Children in Sierra Leone may have the opportunity to learn this art as they grow up and especially when introduced in schools as part of the curriculum. For example, in the United States, an inspirational story about a young elementary school kid, Ellora, a nine year old girl was part of a Kids Baking Championship contest, a baking event that brings young bakers from all over America to work with various ingredients to make unique desserts for a chance to win \$25,000. Ellora had a brain tumor and needed operation, yet she expressed her interest in pushing forward with the contest and could not reveal her diagnosis and eminent surgery to the judges because she wanted to be judged by the content of her abilities not sympathy. Her passion for the art stood out among those who knew her condition and that helped to create awareness about how a deadly disease condition could not even stand in the way of a determined kid (The Wrangler, Kyle de best, 2022).

Baking has also been a source of therapy for many mental health clients. In fact, in one therapy section, a client reported that the fun she gets from baking has been more helpful than her other therapies and was quoted as saying, "where therapy did not work, baking did" (Legg 2018). Furthermore, Farmer, Touchton-Leonard, and Ross (2018) noted that evidence-based cooking interventions have been used to improve nutritional status, weight-related issues, and cooking skills among low-income populations and in some patient populations such as those with type 2 diabetes, cardiovascular disease, and cancer (Aycinena et al., 2017; Rees, Hinds, O'Mara-Eves, & Thomas, 2012; Reicks, Trofholz, Stang, & Laska, 2014). Some research studies found cooking interventions result in favourable changes in health status and dietary intake and to yield positive changes in cooking self-efficacy, attitudes, and behaviours toward cooking (Reicks et al., 2014). Similarly, cooking groups help to improve eating behaviors within specific patient populations (Clark, Bezyak, & Testerman, 2015). Sometimes, cooking groups have also been used in patients with eating disorders, such as anorexia nervosa, to help improve eating habits (Lock, Williams, Bamford, & Lacey, 2012).

Considering all these benefits derived from baking, it is unfortunate to note that the younger adult population has failed to grasp this opportunity. The study explored bakery services as an alternative profitable business enterprise for the younger generation and provide knowledge that may help bridge the gap in literature about dry heat ovens in Sierra Leone.

Problem Statement

The last two decades provided tremendous technological advancements in all spheres of human existence. These advancements are seen in developed countries that have the economic power to sponsor high capital driven technologies. Developed countries have the capacity to effectively utilize resources to support economic ventures of their choice. Poor nations like Sierra Leone lack the overhead cost and vital resources for big technological establishments and must turn to appropriate technology to meet their basic needs for food supply, preparation, and preservation; medication; education; energy supply; and other business orientations.

Generally, African countries find it difficult to provide sustainable growth and development on their own but must rely on imports and technology for their survival (Brophy, 2022; Anisere, 2022; Obro-Boateng, 2021). The situation will be much better for them if they embark on appropriate technology. For example, local ovens have been found to be very effective in food preparation such as bread, cakes, and other food items. These consumable food materials are a vital source of energy and economic interest for business. Hence the need arises more than ever to design a compact, easy-to-transfer heating, and drying system that is cost-effective. Local communities can afford this type of oven since the materials need to prepare them are readily at their disposal instead of seeking large sums of money to buy foreign ovens that are subject to other energy requirements and maintenance.

An exploration into the preparation and use of dry heat ovens may help provide insight to younger adults to engage in income generating activities like baking and related culinary businesses. Activities such as the manufacture of different types of ovens, acquiring culinary skills in baking and catering, and other related activities would help empower our communities and change the trajectory of unemployment and poverty in Sierra Leone. The need therefore arises to create the awareness among the younger generation that culinary skills such as baking could be a vital source of income and employment.

Purpose of the study

The purpose of the study is to explore baking and the designing and construction of local, low-cost, dry heat, efficient, earth oven systems using appropriate technology. The study will help bridge the gap in knowledge regarding the designs and preparation of local earth ovens and baking as income-generating business for younger population in Sierra Leone. Furthermore, the study will help to highlight challenges faced by local bakers and help create the awareness and opportunities available in the baking industry for younger adults.

Research Questions

The following research questions guided the study:

RQ1: How are local, low-cost, dry heat, earth ovens prepared to ensure efficiency?

RQ2: What are the different types local ovens commonly used among local communities in Sierra Leone?

RQ3: What are the perceived health and economic benefits of dry heat oven technology?

RQ4: What perceived challenges or barriers do local community bakers face in designing and manufacturing dry heat ovens?

RQ5: What processes and ingredients are involved in preparing bread and queen cake?

RQ6: What recommendations could be advanced to help local communities involved in baking?

Nature of the Study

This descriptive qualitative case study combined with meta-analysis of related literature explores perception of bakers regarding dry heat ovens and baking in Sierra Leone. Related articles were examined and analysed and matched with participant's perceptions to buttress or give a different dimension to the phenomenon under study. A quantitative study was not appropriate for this study because it could not provide an in-depth understanding (Creswell & Creswell, 2018) of the perceptions of participants or explain the hands-on process of baking and preparing and operating dry heat ovens.

Significance of the Study

The study is significant because, first, it adds to existing literature and helps bridge the gap in knowledge regarding the preparation and use of local oven systems used for baking in Sierra Leone. Secondly, the study may be of significance to community development project officials and younger adults who may seek for alternative income-generating ventures and

life skills (Gupta, 2021). The report from this study may help invoke the possibility of dry heat oven production and marketing for some people. Thirdly, amid the energy crisis in Sierra Leone, people will find this information useful in their search for alternative ways to store or preserve their food for a reasonable time. Finally, other researchers and students in the food science and nutrition discipline in schools, college, and universities in Sierra Leone and other parts of the world may find this article useful in their search for related literature regarding local ovens.

II. LITERATURE REVIEW

The aim of the study is to explore the designing and construction of local dry oven systems from the perspective of appropriate technology among local communities in Sierra Leone. The search for related literature was done by examining academic journals, databases, local news media, and local expert knowledge. Using search words like local ovens, baking, dry heat, high efficiency, mud, and fire, generated several thousands of articles. The search was narrowed down to by the inclusion of appropriate technology, Africa, and Sierra Leone. We decided to include some local knowledge and practices from other countries but gave more attention to the Sierra Leonean experience.

Conceptual Framework

The study is guided by the concept of Appropriate Technology, Social Enterprise, and Heat Transfer.

Appropriate Technology

Applications of appropriate technology are seen in various disciplines all over the developing world, especially in African countries with Sierra Leone been no exception. Sierra Leoneans use ovens and other forms of dry heat sources to bake food products including bread, cakes, pies, pastries, and cookies used for individual consumption and retail to restaurants and markets. Many developing countries gravitated towards the use of appropriate technology for the production and processing of food. Appropriate technology is the use of technological knowledge geared towards the development of rural people. It is considered as a movement encompassing technological choices and applications that is small-scale, affordable by local communities, decentralized, labor-intensive, energy-efficient, environmentally sustainable, and locally autonomous (Bull, 1999; Sianipar, Dowaki, Yudoko, & Adhiutama, 2013). Evidence of this movement has been seen all over the world as far back as the BCs. For example, around 600 BC ancient Greece invented the first enclosed ovens (Morgan, 2012); in 2014 the oldest oven known in existence was discovered in Croatia which dated back to 6500 years prior. Likewise, in Turkey and Palestine, archaeologists have found ovens and countertop workspaces dating back to 5600 BC (Baking, 2020). These applications were appropriate based on the level of advancement of those civilizations at that time.

Social Enterprise

The behavioral theory of social entrepreneurship deals with the creation of social ventures and organizations to mobilize resources and bring about sustainable social change. Social enterprises could involve both non-profit or for-profit organizations with the goal of generating profits, and outcomes that engulfs social, cultural, economic, or environmental benefits. In addition, social enterprises are a source of employment for many individuals coming from low income and disadvantaged communities.

The behavioral theory helps to provide a formidable framework for the study. It is important to note that the social enterprise model best fit the present economic situation in Sierra Leone and may help to empower local communities.

Heat Transfer

The guiding principle behind the operation of local dry heat ovens is heat transfer. The process of baking is very complex and sometimes difficult to understand or describe. In most cases, baking is impacted by the design of the oven and the ability to transfer and control heat. However, for the baker, it is a matter of temperatures and turbulence at specific stages transferred within the oven that matters much. Generally, there are three modes of heat transfer; radiation, conduction and convection (Clyde, 2022), and all these modes occur during baking processes (Davidson, 2022).

Conduction, Convection, and Radiation

Conduction: Conduction is the transfer of heat between two materials in contact with each other. Normally, good conductors are preferred because they do well in transferring heat to each other when in direct contact. Although in the baking process heat is not directly transferred to the food material, conduction occurs between the container the food material is placed and the heat source.

Convection: Convection occurs when heat is transferred in the form of liquid or gas from hot to cold areas. In dry heat methods, like baking, convection pertains to the movement of heated gas from one medium to the other. In convectional ovens, fans placed inside the ovens circulates the heat and facilitates faster convective heat transfer.

Radiation: In radiation, contact between the source of heat and the food substance is not necessary. Heat is transferred through space by thermal or infrared radiation. This type of heat transfer is seen in conventional ovens as the heat bounces around the oven walls to heat up the food inside. This is the principle used in microwaves.

In baking, the three modes of heat transfer occur and therefore the design of local ovens should utilize these methods of heat transfer. The effective combination of appropriate technology, social enterprise, and heat transfer concepts provides a perfect framework to discuss this phenomenon.

Different Types of Local Ovens

There are different types of oven used for food preparation in Sierra Leone including gas and mud ovens. However, emphasis is placed on dry heat mud ovens.

Gas Baking Oven

The importance attached to the design of the gas baking oven is to accomplish a fast heating and drying system without burning or damaging the food one wants to bake. The attachment of the temperature regulator sensor regulates the level of temperature in the system at a given time (Ozilgen & Heil, 1994). This helps in dictating the engineer temperature at which a type and size of food will bake. And after setting the cylinder gauge and control valve to the appropriate point, immediately after the temperature reaches the normal baking temperature, the oven is open to remove the food. The sensor helps in determine when the food is turned to evenly spread the heat. The design of such ovens helps to achieve a low cost, longer life span, quick heating and drying technique, compactness, portability, and ease of transfer.

Dry Heat Mud Ovens

Mud ovens are the common choice for baking bread among local communities in Sierra Leone. Details about mud ovens are discussed below.

Dry Heat Method Cooking Techniques

There are different cooking method using dry heat technology including baking, broiling, frying, grilling, and roasting.

1) Baking

Baking is a cooking technique that uses hot air that transfers heat to the food and creates a variety of dishes. It produces different results based on temperature, position, and type of baking pan used. The conventional oven uses hot air and heat radiation off the oven walls, while the convection oven has a fan that blows the hot air around to cook your food. The convection oven cooks faster than a conventional oven since the heat transfers faster than the other oven. This results in a shorter cooking time.

2) Broiling

Broiling is almost the same as grilling. It is a dry heat cooking technique that is achieved by placing a heat source with a high temperature above the food you are cooking. Broiled chicken is a typical example where the whole chicken dressed in herbs and spices, then put into the oven and cooked with just the heat source above the chicken.

3) Roasting

Roasting is almost the same as baking, but the term is used when cooking meat and poultry. Roasting also uses fat or other liquid mixture to create a unique flavor for the meat being cooked and to prevent it from drying. Roasting usually uses both heat sources of the oven, above and below the food.

4) Grilling

Grilling is done by cooking the food in a short period of time under high heat. Compared to broiling, the heat source is under the food in grilling. Common heat sources in grilling are charcoal and gas. Grilling can be done directly with the heat source or with a metal grill that heats up then transfers the heat to the food.

5) *Frying*

Frying is done when food materials such as meat, potatoes, fish, are cooked in hot fats or oils, usually done with a shallow oil bath in a pan over a fire. There is also deep frying in which the food is completely immersed in a deeper pot of hot oil.

III. METHODS

The study was part of a project for the partial fulfilment of the award of associate degree in food science at Njala university college, university of Sierra Leone. Modifications were made to the study to enhance its content and publication. The purpose of this descriptive qualitative case study was to explore and solicit an in-depth understanding of the process of designing, manufacturing, and use of low cost, dry heat ovens for baking guided by the concept of appropriate technology. A quantitative study would not be appropriate for this study because it is limited to survey questions which do not provide an in-depth understanding of a phenomenon under study (Creswell & Creswell, 2018).

The primary researcher randomly selected three communities with baking and mud oven manufacturing experience and settled down with one due to cost, proximity, and convenience. Out of five willing bakers in the community, the researcher settled on two and retain the other three for backup should the current volunteers back out of the study. The service of the volunteers was employed to describe how local dry heat ovens are prepared and to share their experiences in the baking enterprise. Other members of the baking community also presented their views while the primary researcher and classmates observed and recorded vital information that are later used to produce this paper.

Construction and Design of Local Ovens

The primary researcher and classmates met with volunteers at the designated site for demonstration. The head of the local community volunteer assembled his team and started explaining the process for dry heat mud oven manufacture and design. The volunteer proceeded by listing tools needed. He said,

“We start by assembling the following tools and materials: Shovels, Cutlasses, Ropes, Pickaxes, Clay Soil, Wheelbarrows, Water hose, buckets, and water access, and Sticks. The number of tools depend on the size of oven or the number of people working on the project. We first map out the area with pegs and ropes, then we dig out and levelling the trench area. For the oven to have a very good foundation, some people use bricks made of mud or cement. It depends on what you can afford. But the goal is to have a strong foundation. Sometimes, you may have an old structure with may be broken down to erect a new structure, but if the foundation is still strong, there no need to build another one.” (Community participant, n.d).

The foundation is prepared depending on the need of the baker and resources available. The volunteer then continued to explain and demonstrate the next step in the construction process. He said,

The Construction Process

“We clear the site for the reconstruction of the new oven and prepared sticks appropriately flexible to endure bends, and then tied to form oval structure as seeing in the photos below. In some cases, old structures are broken down to erect new ones. The oval structure is then covered with mud to close the spaces in between the structure. If we are starting without prior foundation, we construct one, then move on to preparing the top oval structure with sticks and ropes. Next, more layers of mud are used to cover the oval structure. An entrance to the structure is secured with an oval structure to form the mouth of the oven. More mud was used to cover the structure to form a fortified structural enclosure that could support the heat and retain for a long period of time.” (Community participant, n.d).

The next stage in the process involves the “drying and strengthening” of the oven. The volunteer continued to describe the drying and strengthening process.

The Dry and Strengthening Process

“When the oven has been prepared and fortified with mud, we now want to dry it and strengthen the structure. So, what we do is to get dry material or wood and burn it inside the oven. The process will generate heat that will slowly dry up the mud and strengthen the structure. When the dry is dry, it is now ready for use. But we must have the oven in an enclosed place or large room to protect the structure form rain and to allow for easy manoeuvre during the baking and packing of bread and other bakery products.” (Community participant, n.d).

Please see fig. 1 below



Figure 1: Photos taken from the construction site

Process of Baking Bread in Local Dry Heat Mud Ovens

Local low-cost bread bakeries comprise of a mud oven prepared as described above. Materials needed for the preparation involve flour, baking soda, yeast, sugar, mixer, baking trays, fire-woods, water, butter, and other ingredients depending on the type of bread. The quantity of bread produced depends on whether it is for commercial use or home-made consumption.

Usually, the flour is meticulously mixed and placed in baking trays made of metals. Metals are good conductors of heat. Burning firewood is placed in the oven to provide the source of heat and these trays of flour are placed into the oven and closed. Some wood-fired bakeries commonly have steam injection systems to manage the look of their bread and ensure proper crust development and cartelization. In cases where this steam system is unavailable, bakers may still get good results if they monitor the process carefully. When these baking trays, usually 4' x 3' hearth is fully loaded with bread, the dough itself creates a fair bit of steam as it bakes, although the steam is not enough to create the kind of effect needed. In such a case, first, all ash and coals are raked out of the oven. When the optimum hearth temperature is very close, we brush the hearth clean, swab it very quickly with a damp piece of towel attached to a handle to remove residual ash, and then seal the door. About ten minutes before the pieces of bread are loaded, we give the interior a ten-second spray from a dedicated garden sprayer with a brass wand, reaching in with the wand to the back of the hearth, then moving forward toward the mouth of the oven. The door is resealed.

Depending on the size of the oven, a garden sprayer or a plastic spray bottle might be needed to water spray the dough to provide the required moisture to create a visible steam chamber. Bakers use precaution by wearing long oven gloves that reach up your forearms when you do this. There should be visible steam in the chamber that helps to transfer heat by convection. Once you have loaded your loaves of bread into the oven, add more steam with another ten-second spray. Don't spray the pieces of bread directly. Instead, point the nozzle above them, about halfway between them and the dome. Seal the door as tight as you can. If you have trouble getting a good seal, lean a brick against the door. Steam keeps the surface of the loaves of bread moist for the first crucial few minutes of baking. Moisture allows the heat from the hearth to drive the gasses upwards inside the dough, expanding the loaf to create tremendous volume through an "oven spring." Once the steam dissipates, the crust sets, the caramelization (browning) of the sugars in the grain starts, and the formation of a characteristically chewy crust. After experimentation, you might find that another quick spray, about five minutes into your baking time, improves the results. Conversely, for hearth bread, you want them to finish baking in a dry environment, so crack the oven door open slightly during the last few minutes or so to finish the crust. It's a difficult rule to follow, but all loaves of bread should be allowed to cool completely on wire racks before slicing. If you don't wait, the flavour will not be fully developed. (See figure 2. Hands on processing with female researcher and peers seen below)



Figure 2: Primary Researcher and Classmates Preparing Flour to Bake Bread

Preparation of Queen Cake, Cup Cake, and Muffin in Local Oven

Local preparation of queen cake described here is common in Sierra Leone, but we do not deny there may be variations among individuals. Some bakers may follow prescribed procedures in cookbooks. However, the process of baking utilizes the same principle, but the differences lie in the ingredients. The following ingredients are needed: cream sugar, flour, butter, eggs, and some other items for flavour. The process is as follows:

“Mix the cream sugar and softened butter together until very fluffy with no lumps, whip eggs with a whisk until light and fluffy; add flour and whip to a froth. Fold the egg-flour mixture with butter-sugar cream. Fold in additional ingredients. Be gentle to maintain the air that has been incorporated. Pour into a well-buttered floured tube or Bundt pan. Put the Queens Cake Vanilla into the mixer and run for 1 minute at low speed. Add the rest of the ingredients and mix for 1 minute at low speed and 3 minutes at second speed. Stop the mixer and hand mix the dough from the bottom to the top. Run the mixer for 4 minutes at low speed. Pour into container for baking. Bake in a moderate oven, 350° for about an hour. Round shaped Cake - Bake 600 gr. of dough for 50 – 60 minutes at 180° C (360° F); Cup Cake - Bake 40 - 60 gr. of dough for 30 minutes at 190° C (380° F); Muffin Bake 85 - 130 gr. of dough for 30 - 40 minutes at 170 - 180° C (340 - 360° F).” (Personal communication, n.d.)

The materials and process described here are those prescribed by the researcher and peers and are not hard and fast rule. Other bakers may use measures that best fit their taste.

IV. FINDINGS AND RESULTS

A meta-analysis of three different articles dealing with males, females, and married couples involved in the baking enterprise was done using the following keywords and/phrases food source, economic, satisfaction, need financing, labour issues, land problems, illiteracy, form of career, high prices, demand, and product supply. These frequency of occurrence of these themes matched with participants perceptions were used to discuss the health and economic benefits of baking, and challenges faced by bakers in the local communities, and to draw inferences to give an in-depth understanding of the topic. (See figure 3 below).

Health and Economic Benefits of Dry Heat Oven Baking Technology

The practice of appropriate technology often proves to be very useful in rural communities where the availability of low-cost resources is an advantage for the local community. During difficult times like this, engaging in social enterprise would require access to financing and resources to facilitate enormous community involvement. Baking provides a source of

healthy food and stable mental health for members of the baking community. Although bread and cakes are not the staple food for Sierra Leoneans, the sale of these products would facilitate the purchase of rice and other food ingredients for healthy meal preparation and consumption. Alliance Bakery (n.d.) reported that psychologist discovered baking and cooking can have therapeutic effects helping people deal with stress, depression, addiction, and anxiety.

From the chart below, the phrase “food” source appeared 46 times, source of income 28 times and satisfaction with what they are doing 30 times. The phrase “would make baking a career” appeared 68 times. Even though only three articles were analysed specifically to meet the three parameters male, females, and married couples with children, the results are encouraging as they jived with the perspectives of participants. Baking provided a means of livelihood for many bakers in the community as they may use proceeds from the sale of their bakery products to buy healthy food and pay for medical attention. This perception was prevalent among participants in the study.

Figure 3 below provide a graphical representation of the thematic analysis of the three articles using phrases or words as seen below. The number of times those phrases or words appeared in the analysis is outlined and inferences were drawn and matched with participants responses during the hands-on exercise for corroboration.

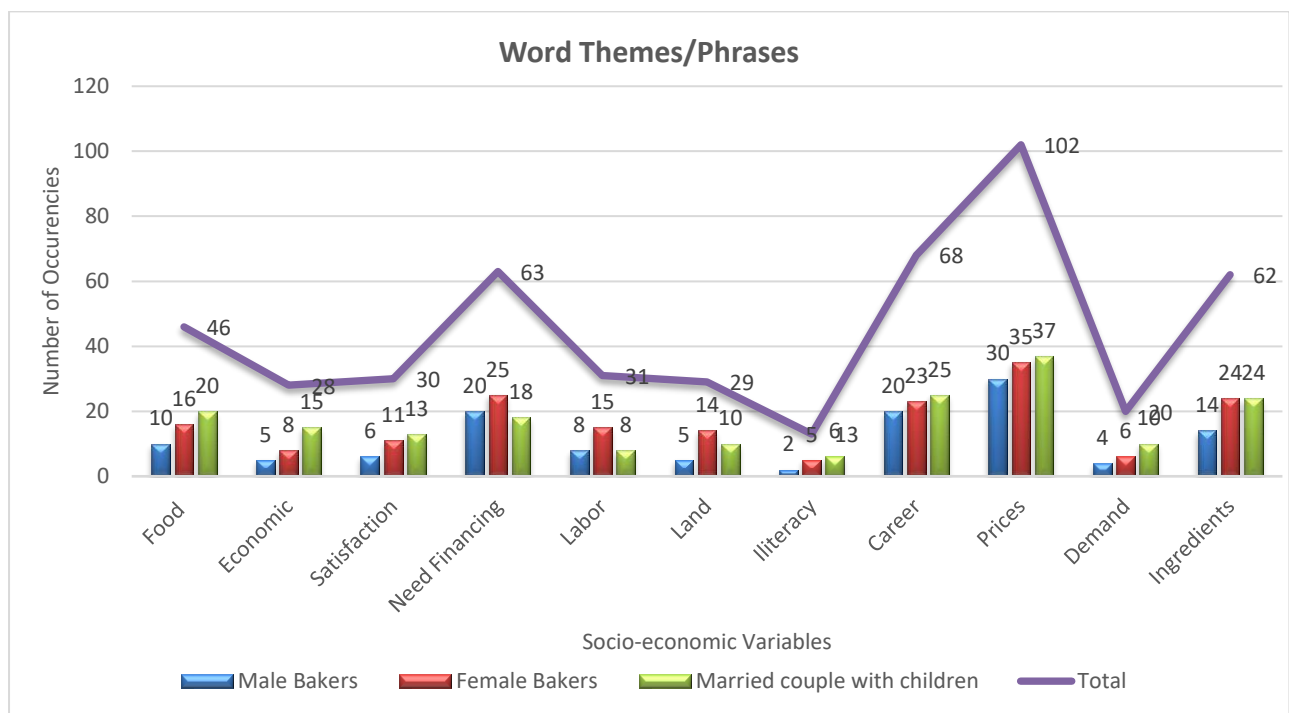


Figure 3. Word Themes

V. DISCUSSION

Baking provides an economic source for many people around the globe. It is not a surprise to hear participants express their satisfaction with their present economic status and would rather prefer baking as a career. Baking as a career does not require a university education but the average baker is better off than university graduates with no job. Participants stated their willingness to hold on to their baking careers as a source of income. In addition, the phrase career appeared 68 times in the articles analysed. This thinking is consistent with the current rise in vocational training in the culinary services discipline in schools and colleges in the country.

The process of baking is also known to eliminate pathogen in food and provides immediate relief from hunger. Aside from the palatability of cakes and other bakery products, having food to eat, and a source of income provides peace of mind and self-confidence for local community members. The word “food” appeared 46 times in the analysis as bakery products like bread provides a source of food for many families in Sierra Leone. Some families eat bread for breakfast while others may snack on it for dinner or on a “as needed basis.” Since bread is not the staple food for Sierra Leoneans, we do not expect much attention given to the product even though its consumption is significantly high in the country.

Baking as an economic enterprise is seen mostly among females and married couples with children even though the proportion of males who are engaged in the baking industry as seen in collaboration with their wives. Baking is a source of

income for many families and may express their satisfaction of engaging in baking as a profession. Engagement in the baking enterprise will help reduce the crime rates, idleness, and civil strife in our communities.

Illiteracy did not play any significant role in baking or culinary services as both the educated and illiterate share interest in the practice. Generally, women love baking as a hobby or fun exercise.

Further discussions of the findings are outlined below.

Challenges Faced by Local Bakery Enterprises

Figure 3 provides reasonable clues to some of the challenges faced by bakers in our communities. The need for financing (63), labour (31), prices (102) and supply of products (62) presented among other items with the highest occurrences in the meta-analysis.

Financing

The need for financing was common in all the articles analysed. Participants in the local communities also expressed the need for financing in order to consider baking as a business. When asked about the making use of the microcredit - a government program, participants showed interest but could not meet qualification requirements including the presentation of collaterals. Furthermore, the present economic situation had impacted the price of baking supplies such as flour, sugar, and other ingredients. Cost is a paramount factor that prevent the diversification of their businesses and as a result, they can only embark on small scale bakery enterprises.

Labour

Single male and female bakery owners complained about paying for labour which had hindered them from embarking on large scale baking services. The phrase “labour or labour intensive” occurred 31 times in the analysis as a requirement for both large and small-scale ventures. However, single males and married couples with children did not consider labour as an inhibiting factor unlike single female entrepreneurs who must rely on hiring paid labour for their businesses. Single able-bodied males may work on their own or ask friends to help them, while married couples with children are a formidable labour force on their own.

Prices of Ingredients

The current global inflation has tremendously impacted the prices of basic ingredients used in baking. With the increase in cost of ingredients, bakers are obliged to increase the cost of hire to product a unit product of bakery products like wedding cakes. Many people will settle for common bakery products like bread, cookies, and muffins and may shy away from more expensive products which in turn may impact profit margins.

Supply of Products

Recently, many countries experienced the shortage of certain basic food supplies including materials used for baking like flour and sugar, especially if those supplies are coming from Ukraine. Aside from that, the cost of transporting those supplies internationally as well as locally has increased tremendously. This increase has impacted the cost of production of bakery products which in turn will impact the price of common bakery products like bread, cakes, and muffins.

VI. RECOMMENDATIONS

Based on the findings of the study, we advance the following recommendations.

Implications for Social Change

Investments in dry heat ovens and baking has a great potential for social change in Sierra Leone. Research has shown that the baking is a multibillion-dollar industry in many developed nations (Profit Venture, 2022). With that amount of money circulating in the baking industry, activities to effect social change among the population are possible. Baking may help provide jobs and training for many young adults which may help eradicate idleness, social violence and unrest perpetrated by idleness. Earlier we read about the East Harlem baking cooperative in the United States that facilitated a training program to create new careers for women from all over the world. That baking initiative morphed into entrepreneurship and partnership with other companies by launching a kitchen incubator program to help food companies (Shoukas, 2014). Similar initiatives could be launched in Sierra Leone where young adults could enrol into such programs to form public-private enterprises to produce bakery products for hotels, restaurants, and other retail business in cities around the country.

We recommend government investment in the creation of baking cooperatives as a workforce development and social enterprise venture through public-private and non-profit-private enterprise. The goal is to help train younger adults the art of baking with a social enterprise initiative. Graduates from such training will be guaranteed microfinancing and mentored into the entrepreneurship. The potential for social change is tremendous here.

Implications for Research

Since the study is a school project, we recommend and encourage students to partner with non-government organizations that sponsor local community projects to research and come up with creative ways to diversify the baking industry. Students may research challenges faced by a larger sample size of bakers to create the awareness of problems faced and the perceived alleviation strategies to those problems. Research may help facilitate the involvement of members in the community who find it difficult to engage in the baking enterprise because of those challenges.

Current and future research into the baking industry may provide valuable information that will help bridge the gap in knowledge about the baking industry and dry heat ovens in Sierra Leone. There is limited or no known information about the use of dry heat oven and baking that specifically address the Sierra Leonean context, unlike other countries. Research into the discipline and the publication of results may help create awareness into the baking industry in Sierra Leone.

Implications for Practice and Business

We recommend our younger adults engage baking and other culinary services as a business enterprise that may help create the sense of responsibility and development of skills for practice. Baking has the potential to induce creativity due to constant practice. Many bakers have come up with create menus for bakery products and have written cookbooks that help teach others the art and generate income for the authors. For example, the article “How a young bakers dreams and perseverance gave her a recipe for success” (The Wrangler, Kyle de Best, 2022) is a classical prototype of practice and passion may produce success among many young adults in the world.

Implications for Study Programs in Educational Curricula

There are many renowned schools and universities around the world that have culinary disciplines in their curriculum. Presently, we see a proliferation of private proprietary schools and government institutions with culinary or food science programs. We recommend a continuation of such programs with public-private-institutions, and non-profit-private-institutional cooperation to enhance culinary curricula in our educational institutions.

Research has shown that collaborations among institutions will facilitate effective communication, sharing of knowledge, and peer mentoring to improve life skills in culinary services that enhances creativity. Students may come up with new recipes, designs, and shapes for cakes and other bakery products.

Implications for Nutrition and Health

Baking has always provided a better taste for certain food types compared to their original forms. Since a lot of baking involves the fermentation process, the baked product always tastes better than the other form of food. Some baked products make certain food nutrients available for absorption. Baking can be accompanied with a host of psychological benefits. Baking is a productive form of self-expression and communication. Many emotionally disturbed persons have found solace in baking and has used the practice to relive themselves of stress and use baking for fun. One of the clients of a psychologist confessed that “where therapy did not work, baking did” (Legg 2018).

The therapeutic effects of baking have been recorded throughout history. The creativity and physical activities involved have a lot of mental, physical, emotional, and spiritual benefits for many people. In addition, as an income generating enterprise, it may provide peace of mind, self-esteem, and empowerment to many vulnerable populations.

VII. CONCLUSION

Dry heat ovens technology is among the cheapest methods of baking in rural communities. The application of appropriate technology has proved to be low-cost, efficient, affordable, and has a potential to create social change within communities in Sierra Leone. The present economic situation in Sierra Leone triggered by the global crisis has resulted in people struggling to survive. Currently, prices of commodities are very high, we see global inflation, and jobs are hard to find for many able-bodied adults including university graduates. Many graduates of universities and colleges still seek jobs but to no avail. There is also a national cry for self/youth-empowerment which requires individuals to engage in income-generating activities for nation building and healthy living. Culinary services provide a viable alternative to idleness, victim mentality, and blame gaming. There is proliferation of culinary services and training opportunities for many youths and able-bodied adults which could be a career opportunity or a social enterprise to generate income.

The study helps to illuminate alternative venues for young adults to secure a career and make use of opportunities out there, guarding against the current economic difficulties and unemployment among younger adults. The study also helps to bridge the gap in knowledge about dry heat ovens and baking from the Sierra Leonean perspective.

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