Analyzing the effects of pre-ferments and fermentation time by comparing the textural outcomes of shio pan and pita bread

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Abstract

This study investigates how variations in ingredients and bread making techniques can influence the final structure, characteristics, and flavor of bread. Rather than treating bread making as a simple everyday culinary practice, this research breaks down the bread making processes in a more scientific way. By systematically baking multiple loaves of bread with similar ingredients using varied proportions and procedures, the research identifies the specific role each component plays in dough development and final texture. Two yeasted breads, Pita bread from the Middle East, and Shio Pan from East Asia, were baked to compare how foods with similar ingredients can have varying characteristics in their final form. Data was collected on dough qualities and texture, fermentation timing, and the physical properties of the breads. The study found that the pre-ferment used in the shio pan recipe allowed for a stretchier dough that could be shaped more easily by starting the fermentation process at an earlier stage of bread making. Similarly, a second fermentation period of the shio pan allowed the dough to rise before being baked, resulting in a more airy crumb compared to the pita that was only fermented once. Lastly, the addition of butter in the shio pan resulted in a softer interior with a richer flavor than the pita with no fat in the dough. The butter also allowed the crust of the shio pan to brown more, resulting in a golden brown, crisp exterior. Adjusting the fermentation processes and adding fat to the dough alter a bread's textural outcome.

Introduction

Bread is one of the oldest foods. Earlier forms of bread look different from how it does now, but it has always consisted of the same core ingredients: flour and water. However, varying the amount of each ingredient used, using additional ingredients, or using different techniques of breadmaking can yield different textures and flavors in the final bread. Earlier forms of bread look different from how they do now, yet it remains one of the most universally consumed foods in the world (Cauvain and Young 2007). One major development in breadmaking is the use of leaveners in the dough. Leavening agents such as baking powder and yeast are used to allow dough to rise and create an airy texture.

Bread not only looks different over different time periods, but also around the world. Pita bread from the Middle East and shio pan from East Asia are prime examples of two yeasted breads with similar ingredients which have completely different characteristics and flavor profiles. These breads contain yeast, a type of fungus found in all living organisms. In its natural form, yeast serves as a catalyst for sugar consumption in the fermentation process (Ali et al. 2012). The breakdown of sugars produces carbon dioxide gas, which is what allows yeasted breads to rise and expand. As a result, both pita bread and shio pan have airy, puffed insides.

Pita bread is one of the most ancient foods, with a history dating back thousands of years. Consumed mainly in early Roman, Egyptian and Greek civilizations, the pita bread was highly valuable due to its portability and long shelf life (Luscher 2020). Grains were mashed with water to create the dough, then roasted over an open fire to cook. Modern pita bread is a neutral flatbread with a dry crust and porous crumb. It has a mild taste, and is often paired with other,

more flavorful foods. Over time, pita bread transformed from a survival food to something more widely recognized as an everyday staple in the Middle East.

In contrast to pita bread, shio pan is a modern creation from Japan. Shio pan is the Japanese translation of Salt Bread, and as the name suggests, has a salty, savory, rich flavor. A block of salted butter is wrapped by a strip of bread dough, and is baked until the butter melts out, frying the bottom of the bread roll. The result is a golden brown crust, with a soft, pillowy inside crumb.

In most yeasted breads, the main breadmaking process includes the initial formation of dough, followed by kneading, fermentating, shaping, and baking. Yeast is a common additive in modern breads, mainly used for gas production (Das et al. 2023). Yeast contributes to characteristic taste and aroma and produces CO2 in the dough over a longer period of time (Anjum et al. 2010). During dough formation, the main ingredients, flour and water, are combined to make the main dough. At this stage, the dough is shaggy and sticky, making it difficult to work with. By kneading this dough repeatedly, the mixture comes together and becomes easier to work with. The kneading process serves to uniformly blend the ingredients and foster gluten development within the dough. This process is essential for balancing the dough's texture and overall resistance to deformation (Cauvain and Young 2007). After kneading, the dough is set aside, allowing the yeast to consume sugars and produce gas. Enzymes in the flour and yeast break starch into sugars, yielding carbon dioxide and ethanol, a type of alcohol (Das et al. 2023).These gases are trapped in the dough, making it expand, but it can also make the dough lose its shape and structure. When bread dough rises, gas bubbles grow and connect (Turbin-Orger et al. 2015). By understanding the different roles of breadmaking techniques and individual ingredients, bread recipes can be manipulated to reach a desired outcome. Main differences in outcomes of bread are seen in the texture and flavor of the final product. Texture can be manipulated by gluten structure, hydration, and the amount of fat in the dough. Bread can have different textures in its crust or crumb. The crust is the bread's outer layer, and the crumb is the inside. The morphology of these depends heavily on the amount and size of gas bubbles trapped in the dough. Different textures which can be described as dependent on the ingredients used, but can also be manipulated through breadmaking techniques.

In this study, I investigate the roles different ingredients and techniques have in the textural outcomes of pita and shio pan, two yeasted breads with similar main ingredients. By comparing these two breads, I am exploring which processes create the different textures and flavors observed in the two types of bread.

Methods

To analyze the impact of different variables, two bread varieties were made. The primary focus was on the effects of four core ingredients, flour, water, yeast, and fat. Data collection occurred at each stage of baking for both recipes through temperature monitoring, photography, and physical descriptions.

In the pita bread recipe, the process starts with combining lukewarm water, yeast, sugar and salt. After 15 minutes, flour is added to the yeast mixture, then set aside until the dough doubles in size. After proofing, the dough is transferred to a floured surface and divided into six portions. Each dough piece is rested for 10 minutes before being flattened into approximately 6-inch circles and proofed for a final 15 minutes. Finally, the dough is baked in an oven

preheated to 475 degrees Fahrenheit and baked for 5 to 6 minutes until puffed with golden brown spots.

The shio pan recipe uses a pre-ferment for yeast activation. Pre-ferments, or starters, such as poolish, are portions of already fermented batter that may be added when making dough. It allows for a stretchier dough and more distinct flavor due to longer fermentation. (McGee 2004). For this recipe, a poolish is made using equal parts flour and water, with a small amount of yeast. The mixture is combined, then set aside to ferment for 10-12 hours, or until the substance has doubled in volume. The poolish is then combined with bread flour, cake flour, and water, then rested for 30 minutes before adding the remaining dry ingredients (milk powder, sugar, salt, yeast). After mixing, unsalted butter is incorporated into the dough, and the dough is rested again for twenty minutes. After that, the dough is mixed once again until it no longer sticks to the bowl, is shaped into a ball, and is set to ferment for 80-100 minutes, or until the dough is 2.5 times its initial size. After fermentation, the dough is divided, shaped into ovals, set aside for 15 minutes, then rolled with a chunk of butter in the center. The rolls of dough are proofed one final time until doubled in size, then loaded into an oven preheated to 450 degrees fahrenheit. The oven temperature is then lowered to 400 degrees Fahrenheit and the bread is baked for 10-12 minutes.

To document the variations between the Pita and Shio pan recipes, characteristics are evaluated using sensory scales. Crumb density refers to the amount of air in the bread, and crumb density of bread can range from something that is light and airy to more compressed and tight. The quality of the surface of the bread is defined by its crust. The crust is typically dry, with flaky, crunchy, or soft textures. The internal texture can also vary from soft and doughy to moist or chewy. Finally, variations in flavor and aroma can be described on intensity scales. Typically, flavor profiles fall within the categories of sweet, salty, sour, bitter or umami. Breads with less apparent flavor are described as neutral, whereas more intense flavors can be classified as strong or pungent.

Results/Discussion

Table 1 shows the observations and fermentation processes occurring in each step of the pita bread recipe. The pita dough is initially shaggy and sticky, but becomes smoother and less sticky over time as the gluten is developed. When rested, gas bubbles are released from the dough, and most of the gas gets trapped in the dough. After portioning and resting the dough, the pita bread is baked at 475 degrees fahrenheit. The high temperature cooks the outer crust before the inside, and the moisture in the dough turns into steam and expands, creating a hollow center. The final pita bread has a dry, light brown crust and chewy crumb.

Pita recipe, physical observations and fermentation process

Step	Observations	Micro/Fermentation processes
Initial Yeast Activation	Mixture is has sour, alcohol like odor, is cloudy and light yellow in color, and solids have fully dissolved in water	Yeast consumes sugar and releases co2, becoming more active.
Yeast Activation after	White bubbles have formed at	Yeast has released gas

15 minutes	the top of the mixture. Solution is cloudy and smells sour	bubbles, and particles have settled towards the bottom of the container.
Dough Formation	Mixture is sticky, shaggy, and dense	Gluten structure starts to form with the addition of flour into the mixture.
After Bulk Proof	Dough has doubled in size and has visible air pockets, but still slightly sticky. The dough temperature has also increased after 60 minutes of fermenting.	Yeast continues to release co2, air bubbles are trapped in the dough, making the dough expand.
Portion and Rest	Less sticky, still airy and soft and rises back slowly when poked.	Portioning and shaping the dough pops some of the larger air bubbles. The dough relaxes and becomes softer when rested briefly.
After Baking	Pita has a dry, bubbly crust and hollow, porous interior. The texture is chewy consisting of various air bubbles.	The moisture in the dough has been cooked off in the oven, “setting” the dough.

Table 1: This table shows the steps of the pita recipe and observations of the dough during the process.

Pita Bread Formation Stages



Figure 1.1 The initial mixture of water, yeast, sugar, and salt.	**Figure 1.2** The yeast mixture after 15 minutes. The mixture separated slightly and formed gas bubbles.	**Figure 1.4** Initial dough is sticky and lumpy.

Figure 1.4 After fermenting, the dough doubles in size and is less sticky.

Figure 1.5 Pita dough after portioning and resting.

Figure 1.6 Portioned pita dough is flattened before baking.

Figure 1.7 Final pita dough has a light brown, dry crust.

Table 2 shows the observations and fermentation process of the Shio Pan at each step of baking. Most notably, the pre-ferment developing for hours begins the fermentation and gluten formation at an early stage. After forming the dough, it is kneaded and rested repeatedly, allowing the dough to become smoother and more uniform as the gluten develops. During the bulk fermentation, the yeast produces gases, which are then trapped in the dough, making the dough rise significantly. The dough is portioned and shaped after the fermentation, losing some of the gas when being manipulated. Before baking, the rolls are left out to ferment and trap more air in the dough, expanding in size. While in the oven, the butter in the rolls melt out due to the high temperature of the oven, and the hot melted butter fries the bottom of the roll, creating a crunchy, golden brown bottom. The final bread is salty and rich with a soft, fluffy interior. The center of the roll where the butter originally was leaves a hole in the bread.

Shio pan recipe, physical observations and fermentation process

Step	**Observations**	**Micro/Fermentation Process**
Pre-Ferment	Wet, sticky, runny mixture. Smells like yeast.	Fermentation and gluten formation begins
After 14 hours	Many air bubbles have doubled in size and the mixture is much looser.	The yeast has consumed sugar to produce co2, and gas bubbles escape from the mixture.
Dough Formation	Slightly wet, sticky dough,not stretchy or smooth.	Gluten structure forms further, but is not yet developed.
After 30 minute autolyse	Less sticky and smoother	Gluten is strengthened
Mixing/Kneading	Much smoother, no longer wet to touch.	Gluten is strengthened
90 minute Bulk Fermentation	Dough doubles in size, not sticky, and has air bubbles, no noticeable yeast smell.	Strengthened gluten structure allows the dough to stretch to trap gas bubbles released during yeast fermentation.
Portioning/Shaping	Large air bubbles have popped,and dough is stretchy enough to be shaped and rolled without tearing.	Gluten structure allows dough to be rolled and stretched without tearing.
After 1 hour of resting	Rolls are jiggly and have	More air bubbles have

	doubled in size.	formed, expanding the rolls.
After Bake	The crust of Shio Pan has a moderately hard exterior. The bottom is crispy and darker in color, while the interior of the dough is white, light and fluffy. Dough flavor is neutral, but butter makes it saltier and richer.	Moisture is cooked off.

Table 2: This table shows the steps of the shio pan recipe and observations of the dough during the process.

Shio Pan Formation Stages
The following images were taken of the shio pan at different stages of the recipe.

Figure 2.1 Poolish mixture is sticky, lumpy, and holds its shape.

Figure 2.2 After 12 hours, the poolish loosens and forms gas bubbles.

Figure 2.3 Dough formed when flour and water are added to the poolish.

Figure 2.4 Dough is autolysed for 30 minutes.

Figure 2.5 After 90 minutes of fermenting, the dough doubles in size and is filled with small air bubbles.

Figure 2.6 Dough is divided and rested for 15 minutes.

Figure 2.7 Dough balls are rolled with a stick of butter in the center.

Figure 2.8 Rolls double in size after an hour of resting, and salt is sprinkled on top.

Figure 2.9 Final bread is golden brown on the outside with a crisp crust.

Figure 2.10 The shio pan has a hole in its center, and small air bubbles are dispersed throughout the interior.

Table 3 describes the characteristics of the breads at their final stages and how they are similar or different. Both breads have a harder rust in comparison to the soft interior, but the crumb of the pita has larger air bubbles that are not as uniform as the shio pan. In terms of flavor, the shio pan is rich and very savory, whereas the pita is more plain and neutral, with a grain-like taste.

Shio pan and pita final observations and comparisons

Category	Shio Pan	Pita Bread	Comparison

Crust	Evenly brown, crispy crust. The bottom is dark brown and crunchy.	Dry, soft crust with some large bubbles protruding on the surface and dark brown spots throughout.	Both have a slightly crispy exterior, but pita is more dense, and does not brown as evenly.
Crumb	The crumb is very soft and fine, and the air bubbles are extremely small. Pulls apart in layers rather than tearing in one piece.	Porous with larger air bubbles throughout the interior. Tears easily along the crust.	Both have a large hole in the center, but the crumb texture is more fine in salt bread compared to .
Flavor	Rich, salty from the butter.	Plain, neutral flavor, not much depth on its own.	Shio pan has a more complex flavor profile, while pita does not have much flavor on its own.

Table 3: A comparison of the different taste outcomes between shio pan and pita as observed through the crust, crumb, and flavor from both visual and taste analyses.

Pre-ferments, such as poolish, are portions of already fermented batter that are added when making dough. It allows for a stretchier dough due to a longer fermentation period (McGee 2004). A stretchier shio pan dough can be rolled into its signature shape without tearing, forming the layers of dough and air that make up the shio pan's fluffy structure. In contrast, pita bread requires less fermentation as its desired texture is chewier, which is why the yeast is bloomed directly in water rather than in a pre-ferment. Longer fermentation times result in a more extensible dough and less dense crust (Zghal, M. C., et al). This is in agreement with the textures of shio pan and pita, with the shio pan having more extensibility and less density, as shown in Table 3. Furthermore, the yeast in a poolish takes a longer time to ferment, whereas the yeast in bulk fermentation proves at an increased rate. The poolish had to be left out for over 12 hours to double in size, whereas a bulk ferment takes around 90 minutes to complete. This is because more yeast is used during the bulk fermentation process, allowing the dough to double in size faster. Additionally, the yeast in a poolish makes it looser and less structured when gas bubbles are released, while yeast makes the dough rise during bulk fermentation, as the gluten structure has properly formed at this stage of bread making. More yeast must be added when the dough is made, as the initial amount of yeast in the poolish is not enough to make the dough rise significantly. Poolish starts the fermentation process earlier, but is slow. Directly blooming a larger amount of yeast in warm water produces results much faster than it takes for the poolish to double in size.

Proofing the dough one last time before baking allows the dough to rise more and lets the gluten strengthen. While shaping, the dough loses volume and therefore needs to be proofed one final time before baking to let it relax (Das et al. 2023). Fermenting the rolls one last time

before baking allows the dough to rise to account for the gas lost while rolling and shaping, as seen in Figure 2.6 of the shio pan before going into the oven. As a result of the second fermentation, the final shio pan product has a light crumb, with very small air bubbles (Figure 2.10). On the other hand, the pita bread is only proofed once, resulting in a flatter dough when baking and less complex crumb (Figure 1.7). It does not have to be proofed a second time because it does not require as much shaping as the shio pan so the dough does not lose as much gas.

Pita bread dough goes into the oven flat and round, but as it bakes, the dough rises due to a large air bubble forming in the center. High temperatures of the oven cause the outside to cook faster, trapping moisture inside of the dough. As the moisture inside of the dough gets heated, it expands, forming the signature air pocket of the pita bread. The final product has a hollow pocket in the middle while the crust is dry, bubbly, and soft (Figure 1.7). Shio pan also has a hole in its center, but this is due to the butter block in the roll melting while baking Figure 2.10). Both breads have similar characteristics, but the mechanisms that create them are completely different.

Shio pan has a richer flavor and softer texture than the Pita, which is chewy and savory (Table 3). The butter present in the shio pan dough is responsible for this change, as fats weaken gluten structure, resulting in a softer, less chewy final product (McGee 2004). In addition to this, shio pan includes sugar in its dough. Yeast fermentation occurs by breaking down sugar to produce CO2 gas. More sugar content in comparison to the pita dough allows the shio pan to ferment to a greater extent than the pita. The added sugar also adds complexity to the shio pan. The flavor of pita is more neutral in comparison to the shio pan due to its simplified ingredient list.

Bulk fermentation is a process that both types of bread go through. After initially mixing the dough, the dough is set aside until it doubles in size. During fermentation, the yeast not only consumes sugar to produce gas, but the gluten structure becomes more relaxed. Gases produced by the yeast are trapped in the stretchy dough, making the dough expand and stretch (Figure 1.4, 2.5).

The proofing processes and fat content of the two breads fundamentally change the structure of the bread. For further research, I will isolate these variables in another controlled baking trial. First, I would start by using a pita recipe that includes fat in its dough. This isolates the bread making techniques as the main difference between the Pita and Shio Pan, as both breads will consist of similar ingredients and properties. Second, I will align the Shio Pan and Pita recipes into the same fermentation timeline to match the proofing processes. A second proof of the Pita before baking will allow for more air in the dough, much like the Shio Pan. Finally, I would like to further research the specific properties the poolish adds to the bread. Rather than blooming the yeast directly in water to activate it, the pita recipe will use a polish to start the fermentation process earlier, much like the Shio Pan recipe.

Conclusion

This study of two yeasted breads investigates how variations in ingredients and breadmaking techniques can influence the final structure and flavor. By isolating the exact variables that drive the structural changes between pita and shio pan, this research tracks how specific ingredients and techniques can alter the final products. Both breads were similar in that they both used flour, water, yeast, sugar, and salt. However, the recipes varied in proportions

and fermentation processes. Furthermore, the shio pan recipe called for added ingredients such as butter and milk powder. These variations in the recipes created distinct structures and flavors. Observations made throughout both bread recipes revealed that fermenting the dough for a longer time results in more air bubbles in the dough and a bread texture that is softer and airier rather than chewy. Adding fat not only affects the taste but also the structure of the dough. Additionally, adding butter made the shio pan richer in flavor and also made its crumb softer and more airy. Ultimately, this study demonstrates that final bread products are not only a reflection of the ingredients used, but also of the manipulations applied throughout the breadmaking process. To expand upon these findings and achieve a more conclusive result, the next steps in research will isolate the specific variables and target them. Most notably, the main differences in the two recipes were seen in the use of a poolish, the amount of times the bread was fermented, and the addition of fat in the ingredients. These differences had the greatest impacts on the textural outcomes of the pita and shio pan.

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