Title: The Effect of Protein Fortification on Italian Bread

Abstract: The general idea for the experiment was to determine whether or not Italian bread could be fortified with extra protein to create a post-workout snack that would both replenish muscle glycogen stores and repair and re-build skeletal muscle tissue. Three loaves of bread were made; a control loaf, a loaf with ¾ cup of liquid egg whites added, and a loaf with 40 grams of vanilla protein powder added. Subjectively, the protein powder loaf was far and away the taste panels’ top choice in both flavor and appearance followed by the control loaf and the egg white loaf (refer to tables 3-6). Objectively, the protein powder loaf had the greatest volume, but not as soft of a texture as the control and egg white loaves (refer to tables 2 and 5). In summary, the protein powder loaf would be the all-around best choice for a post-workout snack in terms of replacing muscle glycogen, repairing and re-building skeletal muscle tissue, as well as having the best flavor.

Introduction: During exercise, the body undergoes many changes. Included in those changes is a depletion of energy and muscle tears. Nutrition is only one part of the recovery process, but it is of vital importance for rehydration, refueling the body, and replacing tissue proteins that have suffered wear and tear during the exercise (6).

The purpose of the experiment was to create a food product that would best aid the body in recovery following exercise while maintaining a desirable taste and texture. Italian bread was chosen for the experiment because it consists of the endosperm of the grain and does not include the bran or germ. The most direct effect of whole-grain foods may be in the homeostatic control of blood glucose (7). The initial spike in blood glucose levels caused by the Italian bread will deliver both the protein and the carbohydrate to the muscles as fast as possible, thereby maximizing the recovery process.

Three loaves of bread were prepared. The control loaf consisted of the original bread recipe while the other two loaves were fortified with two different forms of protein. One loaf followed the original recipe, but ¾ cup of liquid egg whites were added. Added to the other loaf was 40 g of vanilla whey protein powder. All loaves were equally treated in terms of baking time and temperature. The only modification made was the addition of egg whites and protein powder.

Methods: The overall design of the experiment involved a two-day bread making process where on the second day, a panel of peers ranked each of the breads on overall appearance, overall flavor, and overall texture. They were then asked which bread they liked the best, factoring in all of the characteristics.

The first day of making the bread was the preparatory stage. Three bigas, or starters, were prepared by mixing ½ teaspoon of active dry yeast with 1 cup of lukewarm water in a large ceramic bowl (a large bowl is needed to allow for proper rising). Then 2 cups of unbleached, all-purpose flour were slowly added while continually mixing the biga. The bowls were all covered in clear plastic wrap and were allowed to sit at room temperature for 6 hours. At this point, the three bowls were put into the refrigerator overnight. Day two of making the bread involved, for each loaf, 2 cups of warm water (about 90 degrees F), 1 package of active dry yeast, 5 cups of all-purpose, unbleached flour, and 2 teaspoons of salt. Using three more large bowls, 2 cups of warm water was
added to each bowl and one package of active dry yeast was then mixed in using a hand-held mixer. After the yeast and water was mixed, the bowls were allowed to sit for 10 minutes until the mixture became bubbly. At this point, the biga (from the day before) and salt were added to the bowls. Also, for the experimental loafs, this is the point at which the additional protein was added. Using a hand-held mixer, the 5 cups of flour were slowly added until everything was well mixed. The bowls were then covered with clear plastic wrap and allowed to sit and rise for 1 hour at room temperature. Then, the wrap was removed and the dough was punched down and mixed by hand several times and re-covered to sit and rise for another hour. The dough from each bowl was then placed on a flour-covered baking sheet (to prevent sticking) and placed in an oven set to 350 degrees F. Also put in the oven was a small baking pan filled with boiling water. The pan was placed on the lower portion of the oven rack with the bread on the top rack. After being in the 350 degree oven for 30 minutes, the bread was rotated 180 degrees and the oven temperature was reduced to 300 degrees F. The bread was then allowed to bake for an additional 30-45 minutes or until it was a golden brown color. The first of the three trials was very successful, therefore, the exact procedure done for trial 1 was done for trials 2 and 3 as well.

The control loaf was labeled 653, the egg white bread was labeled 764, and the protein powder bread was labeled 875. The breads were presented to the taste panel in no particular fashion; however, the center ½ inch of each loaf was not presented to the panel. That portion of the bread was used in the objective tests performed directly after the taste panel was finished with the bread.

Two objective tests were done to measure the texture and volume of each of the loaves of bread (refer to tables 1 and 2). As stated earlier, the center ½ inch of each loaf was used for these tests. The first test performed was to determine texture. This was done immediately following the taste panels’ testing to keep the bread as similar in texture as the panel had experienced (i.e. moistness/dryness). Using a texture analyzer equipped with a cone probe, three measurements were performed on each ½ inch sample to determine the force required to cause a deformation in the samples. Then, the average of the three measurements was determined (refer to table 1). After the texture tests were performed, a seed volume apparatus was used to determine which loaf had the greatest volume (refer to table 2).

**Discussion:** The experiment turned out to be quite a success. Not only did the taste panel prefer the protein powder loaf, but it also contained the most protein of all the loaves (refer to table 7). On a per loaf basis, the control loaf contained about 112 g of protein (1/4 cup of flour contained 4 g protein and 7 total cups were used for each loaf). The egg white loaf contained about 136 g protein (1/4 cup of liquid egg whites contained 8 g protein and ¾ of a cup was added). The protein powder loaf contained about 152 g protein (112 from original recipe plus 40 g from the added powder). It has been shown that ingestion of proteins is important for rapid tissue repair and the initiation of muscle building by, in particular, their essential amino acids (6).

What seems to be concluded from this is that the best post-exercise snack would be the protein powder bread. Second place would probably go to the control loaf because the egg white loaf simply did not contain enough protein to justify its poor taste and appearance. The added egg whites made the dough too “runny” and, as a result, lead to a
flatter, much less appealing loaf. If the trial were to be done again, a possible fix for the problem would be to add extra flour to soak up the egg whites. Another possibility would be to substitute 3 large eggs for the egg whites. The yolk of the egg may help to act as a firming agent in the dough, though it may negatively affect the color of the bread.

The protein powder loaf proved to have an impressive volume (table 2). As stated in the F&N 453 lecture notes on page 225, flour contains small amounts of monosaccharides. These monosaccharides are the food (fuel) for the fungus responsible for much of the volume in breads, yeast. It can therefore be concluded that the volume of the protein powder loaf was larger than the other loaves because the powder (vanilla flavored) contained sugars. The yeast, more sufficiently fueled, was able to perform its job better, thereby enhancing the total loaf volume. If the experiment were to be performed again, it may be interesting to see the results of adding even more protein powder to the dough. An interesting note was that several taste panelists described the taste of the protein powder bread to have a “distinct” flavor, adding that they enjoyed it. They claimed that compared to the control loaf, it was more sweet tasting than sour. This is almost certainly due to the added vanilla protein powder. Therefore, adding even more powder may produce bread that not only will provide greater benefits for exercise recovery, but taste better as well.

Results: The results of the texture analyzer test yielded the following averages for the breads:

- Control loaf – 81.0 g
- Egg white loaf – 72.4 g
- Protein powder loaf – 97.4 g

Table 1

<table>
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<tr>
<th></th>
<th>Control</th>
<th>Egg White</th>
<th>Protein Powder</th>
</tr>
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<tbody>
<tr>
<td>Texture hardness</td>
<td>81.0 g</td>
<td>72.4 g</td>
<td>97.4 g</td>
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<tr>
<td>in grams</td>
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The bar graph shows that the protein powder bread was the hardest (97.4 g of force were required to deform the sample) in terms of texture of the three breads. The likely cause of this is that the dry powder absorbed more water than the other loaves,
creating a drier, harder texture. The egg white bread proved to be the softest (72.4 g of force required to deform the sample) of the three breads. The most likely cause of this was the added liquid of the egg white that produced a higher water to flour ratio.

The volumes of the three breads varied to about the same degree as they did in the texture category. The average volumes of the center ½ inch of each loaf of bread as determined by a seed volume apparatus are as follows:

- Control loaf – 310 cm$^3$
- Egg white loaf – 270 cm$^3$
- Protein powder loaf – 330 cm$^3$

The bar graphs in table 2 show only a small difference between the control sample and the protein powder sample. Again, this is probably due to the yeast being better fueled from the sugars contained in the added vanilla protein powder. The egg white sample had the smallest volume (270 cm$^3$). When the egg white dough was spread on the baking sheet, the added liquid from the egg whites caused the dough to spread out and cover more of the baking sheet than the control and protein powder dough did. This is the most likely cause for the decreased volume in the egg white bread.

As stated in the methods section, the taste panel judged each of the breads based on overall appearance, overall flavor, and overall texture using a sensory evaluation scorecard that ranged from dislike extremely to like extremely. That data was interpreted into a numerical system. All of the scorecards were considered and the averages were taken in each category.
The table represents the taste panels’ average opinion on the appearance of each loaf of bread.

The table represents the taste panels’ average opinion of the flavor of each loaf of bread.
The table represents the taste panels’ average opinion of the texture of each loaf of bread.

The table represents the average overall preference of the taste panel after considering each aspect of the breads (appearance, flavor, and texture).
The table represents the total amount of protein in each loaf after all ingredients had been added.

References


6. Decombaz, Jacques. “Nutrition and recovery of muscle energy stores after exercise.” Nutrition Department, Nestle Reseach Centre, Lausanne, Switzerland.