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Collegiate Athlete Acceptability of Post-Workout Cookies

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Abstract

Consuming foods post-workout is vital for athletes during their recovery. In the marketplace today, athletes have options for these post-workout foods, but these foods tend to be high in simple sugars and total fats, which results in poor recovery. Thus, the purpose of this study was to determine athletes' acceptability of post-workout cookies made with almond-based and coconut-based flours, which are a good source of complex carbohydrates and healthy fats. Collegiate athletes (n=47) evaluated the appearance, sweetness, crumbliness and overall acceptability of these cookies. Objective tests were performed to determine moisture retention, strength, and nutrient composition of the cookies. Paired t-tests were performed to detect differences between the cookies' attributes and objective tests. Results indicated that the participants liked the appearance of the cookie made with coconut flour compared to the cookie made with almond flour ($p < 0.00$,), but accepted both cookies. Both cookies retained a significant amount of moisture, 9.4% for the cookie made with almond flour and 8.65% for the cookie made with coconut flour. The strength of the cookies were each 5.6 grams and were comparable to cookies out on the market. The nutrient compositions of both cookies were similar. Overall, athletes deemed both cookies to be acceptable. However, further reformulations need to be made on the cookies.

Keywords: Sensory evaluation; Almond and Coconut Flour Based Cookies; Athletes and Nutrition

Introduction

Collegiate athletes under-go intense sport-specific training to achieve optimal performance. Training sessions tend to be intense, which induces a high amount of stress on the body [1,2]. For this reason, it is imperative that athletes balance their demanding training with proper nutrition. Refueling with macronutrients during the recovery process is essential as it promotes a quicker and more efficient recovery [3-5]. Carbohydrates are the most important macronutrient to replenish after workouts or competitions. This macronutrient is the body's primary source of energy, in which it maintains athletes' blood glucose levels during exercise and replenishes muscle glycogen [3,5,6]. Protein is another important macronutrient as it is responsible for repairing and rebuilding muscles [5,7]. During exercise, muscle fibers tear and breakdown, and protein rebuilds that damage. Research shows that consuming appropriate amounts of protein post-workout has the greatest benefit in gaining muscle mass [8]. Additionally, Rindom and colleagues [9] indicate that protein increases muscle synthesis rate which produces a positive protein balance. As a result, muscle repair and gain occur [9]. Healthy fats, such as unsaturated fats (mono- and polyunsaturated) are an important macronutrient to include in the diet as they serve as another energy source for longer periods of activity [10]. Moreover, these types of fats may aid in lowering the risk of cardiovascular disease by decreasing low-density lipoprotein (LDL) and triglyceride levels [6,11].

Each macronutrient has a recommended amount and time frame to consume during the recovery process. According to the American College of Sports Medicine and Academy of Nutrition and Dietetics' joint position statement [5], athletes need to consume about 1-1.2 g/kg of carbohydrates within four hours post-workout and 0.25-0.3 g/kg (15-25 g) of protein within two hours post-workout. The emphasis on fat post-workout is negligible, yet total fat intake should be within 20-35% of the athletes' daily diet [7,12]. It is essential athletes consume a balance of macronutrients post-workout because the combination of the macronutrients further enhances muscle synthesis and increases energy stores [3–5]. Achieving a good balance of macronutrients post-workout can be achieved through proper food products.

Athletes may consume food products post-workout to meet their daily macronutrient needs [13]. Food choices depend on many factors such as health beliefs, nutrition knowledge, taste, weight control, and convenience [13,14]. Collegiate athletes sometimes choose protein supplements

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Table 1: Participants' Demographics (n=47).

Participants	Total (%)
Gender	
Male	19 (40%)
Female	28 (60%)
Year in School	
Freshman	21 (45%)
Sophomore	10 (21%)
Junior	11 (23%)
Senior	3 (7%)
Sport	
Football	23 (49%)
Basketball	12 (27%)
Track & Field	2 (4%)
Cross Country	2 (4%)
Golf	2 (4%)
Tennis	2 (4%)
Softball	1 (2%)
Baseball	1 (2%)
Volleyball	1 (2%)
Soccer	1 (2%)

Table 2: Likert Scale Results (n=47).

Attributes	Cookie made with Almond Flour Mean (Standard Deviation)	Cookie made with Coconut Flour Mean (Standard Deviation)	t	df	P-value
Taste (Sweetness)	5.23 (2.91)	5.74 (3.39)	-.84	46	.40
Appearance (Pleasing)	6.95 (3.52)	8.55 (2.94)	-3.14	46	.003
Texture (Crumbliness)	6.48 (3.34)	6.54 (3.38)	-.12	46	.90

Table 3: Hedonic Scale Paired t-test Results (n=46).

Flours	Mean (Standard Deviation)	t	df	p-value
Cookie made with Almond Flour	5.96 (1.66)	-5.15	45	0.00
Cookie made with Coconut Flour	6.46 (1.94)			

that are made with whey or casein to enhance their performance or recover from their training [8,15]. Whey protein contains a variety of essential amino acids and has a longer aminoacidemia period and digestion rates which contribute to increased muscle protein synthesis [8]. Even though consuming protein bars may aid in the athlete's recovery, these protein bars may have less than ideal carbohydrate types. Carbohydrates are essential in restoring glycogen stores post-workout [16-18]. However, sugars such as sucrose, glucose, fructose, and high -fructose corn syrup are added during the processing of these bars and have been classified as "empty calories" as they increase energy intake, but do not provide many essential nutrients for the body [19]. Furthermore, consumption of added sugars can cause inflammation. Inflammation is damaging for athletes because it impairs their recovery as it is associated with muscle soreness, swelling and discomfort [4]. Consequently, athletes' diets need to contain minimal amounts of added sugars. Thus, some athletes may lean toward products with natural ingredients to eliminate any potential banned ingredient in these processed products [20]. However, in the current market, there are a lack of options for post-workout food sources, especially snack type foods such as cookies, made with whole or natural ingredients and the appropriate balance of macronutrients. Thus, the purpose of this research study was to conduct sensory evaluations and objective tests on post-workout cookies made with either almond flour or coconut flour among collegiate athletes.

Methodology and Materials

Data collection was performed in an athlete academic center room at a university in the Midwestern part of the United States. Athletes were simultaneously given an almond flour based cookie and a coconut flour based cookie. Each sample was provided in a 2-ounce sample cup labeled with a random three-digit number. Using paper sensory tests, participants were asked to taste and rank the appearance, sweetness, crumbliness and acceptability of each cookie.

Cookie development

Preparation of both cookie variations took place on the university campus. Both formulas were made with similar ingredients, with the exceptions of the flour source. The constant ingredients for a 368.7g batch of each cookie type were: oat protein (135g) (supplied by Tate & Lyle), Dannon Greek yogurt (61g), Crisco vegetable oil (28g), eggs (50g), vanilla extract (4.2g), and monk fruit extract (0.5g) (supplied by Tate & Lyle). The protein flours-almond (90g) and coconut (90g) - were the varying ingredients. These flours (supplied by Hodgson Mills) were chosen as they are naturally high in protein, fiber, and contain high amounts of mono and polyunsaturated fats [21-24]. All the ingredients were chosen based on the purpose of the cookies.

Testing procedure

Athletes randomly participated, as it was a come as you please method during the sensory evaluations, in a private room on campus. Athletes were informed of the ingredients of the cookies, completed the sensory evaluation surveys, which included demographic questions and consumption of post-workout protein bars. Athletes consented and were able to withdraw at any point during the sensory evaluation. SPSS v24 was used for the sensory evaluations to determine the total count, percentages, and paired t-test results. Paired t-tests were used to detect a difference between athlete's acceptability of the almond flour and coconut flour cookies.

Participants

A random sample of 47 male (60%) and female (40%) student athletes, representing various ages and sports, participated. Participants mainly were in football (49%) with other sports represented from basketball (27%) to soccer (2%). The majority (47%) of athletes were considered freshmen (Table 1). All the participants were untrained with no previous taste testing experience.

Sensory evaluations

An unstructured scale and a hedonic scale were utilized to evaluate participants' acceptability of the cookies. The unstructured scale evaluated sweetness, appearance, and crumbliness for both variations. Due to the nature of the test, three zones were provided with specific destinations (very characteristic, neutral, not characteristic). The participants were asked to make a mark on the line that indicated their thoughts of the characteristic of each cookie. Marks from the far-left end to the middle were interpreted as "not (characteristic)" such as not sweet, not pleasing to the eye or not crumbly. Marks around the middle of line were noted as neutral such as sweet, neither pleasing nor not pleasing to the eye or crumbly. Marks made between the middle and far-right of the line

were interpreted as "very (characteristic)" such as very sweet, pleasing to the eye or very crumbly. When analyzing the markings from this scale, the researcher measured the length of the line, which was at 13cm. The researchers determined "not characteristic" to be a score from 1-4.9cm, "neutral characteristic" to be a score from 5-9cm, and "very characteristic" to be a score from 9.1-13cm. The Hedonic scale test evaluated participants acceptability of the cookies using a 9-point scale ranging from "dislike extremely" (1) to "like extremely" (9).

Objective evaluations

Three objective evaluations were performed to evaluate moisture retainability and cookie strength. The means, standard deviations, and differences were determined from a paired t-test using SPSS v24. The nutrient content of both cookie formulations were analyzed via the nutrition labels of individual ingredients and the USDA nutrient composition database [25].

Wettability test

A 50g sized sample of each cookie was recorded as the dry weight (DW). The sample was then emerged in 100mL of water. After five seconds expired, the now wet sample was weighed and the value was recorded as the wet weight (WW). The difference between the DW and WW of each cookie was calculated. Four runs of this test were performed with each type of cookie.

Cookie strength

A shortometer instrument (Model 602, Computer Controlled Machines) was used to test the strength of both cookies. A five-gram cookie sample was placed on a platform. A lever was contracted and released which measured the amount of force (g) it took to break the cookie. Four runs of this test were performed with each type of cookie.

Nutrient content

Nutrient analyses were conducted for both cookie formulations to determine if the post-workout cookies contained adequate amounts of carbohydrates, protein, and total fat. Nutrition labels from the individual ingredients and the USDA's Food Composition Database [25] were used to calculate the amounts of the nutrients. The calculations were based on one serving (30g).

Results and Discussion

Unstructured scale test

The unstructured scale test (Table 2) focused on evaluating the sweetness, appearance and crumbliness of the two cookie variations. Sixty-six percent of participants indicated the cookie made with coconut flour was pleasing compared to 39% who indicated the cookie made with almond flour was pleasing in appearance ($p<0.003$). The reasoning behind less participants indicating the cookie made with almond flour was pleasing to the eye could have been due to the processing of the almond flour. Almond flour is made by grinding whole unblanched almonds. This process creates an uneven color as the skin and inside of the almond produce a dark and white color, respectively [26,27]. Regarding sweetness and crumbliness, the responses were similar, in which participants perceived these cookies to be neutral characteristics in both areas, thus it is difficult to discern the alterations to the recipes for both cookies (Table 2).

Hedonic scale

When analyzing the results of the hedonic scale test (Table 3), the cookie made with coconut flour was found to be more acceptable than the cookie made with almond flour ($p < 0.00$). This coincides with the results from the unstructured scale in which participants preferred the sweetness, appearance, and crumbliness of the cookie made with coconut flour compared to the cookie made with almond flour.

Table 4: Consumption of Protein Bars (n=47).

Description	Total (%)
Eat Protein Bars	
Yes	37 (79%)
No	10 (21%)
Frequency	
< 1 month	3 (6%)
1-3 per month	12 (26%)
1 per week	3 (6%)
2-4 per week	8 (17%)
5-6 per week	4 (11%)
1 per day	5 (11%)
2-3 per day	1 (2%)
4-5 per day	0
Do not consume	11 (23%)
Type of Bar	
Gatorade Fuel Bars	22 (47%)
Pure Protein	7 (21%)
Power Bars	4 (9%)
Other	6 (13%)
Consume AF cookie post-workout	
Yes	30 (64%)
No	16 (34%)
Consume CF cookie post-workout	
Yes	33 (70%)
No	14 (30%)
NV alter AF cookie acceptance	
Yes	27 (57%)
No	20 (43%)
NV alter CF cookie acceptance	
Yes	27 (57%)
No	20 (43%)

Included on the hedonic scale were additional questions regarding participants' consumption of protein bars, the frequency and type of protein bars the participants consumed, if the nutrition value (NV) altered their acceptability of these cookies, and whether or not they would consume these cookies post-workout (Table 4). The majority of participants (79%) consumed protein bars with at least 26% indicating they consumed 1-3 protein bars per month. An additional question was asked which type of protein supplements they consumed. Almost half of the participants (47%) consumed Gatorade Fuel Bars. Gatorade Fuel Bars are provided to the athletes at the University where this study took place, thus the reason most indicated they consumed them. These Gatorade fuel bars have a different formula and taste than the tested cookies, so the results from the sensory test were hypothesized to reflect an accurate acceptance of the post-workout cookies.

Table 5: Moisture Retainability (Wettability Test) Results.

	Cookie made with Almond Flour			Cookie made with Coconut Flour			t	df	p-value
	DW	WW	Water Retained (WR%)	DW	WW	Water Retained (WR%)			
Mean (SD)	30.45 (.53)	33.65 (.44)	9.4 (.49)	31.75 (.54)	34.7 (.50)	8.65 (.70)	1.85	3	.16

Table 6: Cookie Strength (Shortometer Test) Results.

Flours	Mean (SD)	t	df	p-value
Almond	5.23 g (.29)	.84	3	.46
Coconut	5.10 g (.08)			

Wettability test

Results from the wettability tests showed that both variations retained small amounts of moisture and were not statistically different from one another ($p > 0.05$). In other words, the cookies were moist. The results of this test were compared to another study's results that indicated a standard value ranging from 1-3% of water weight retained from cookies made with almond and coconut flours [28]. The results from this study showed the opposite in that both cookies retained more than 8% (Table 5). The cookie made with almond flour retained slightly more moisture (9.4%) than the cookie made with coconut flour (8.6%). While stirring the coconut flour in the preparation of making the cookie, it soaked up water quicker, making it a drier mixture than the cookie made with almond flour. Researchers further explained this as the crude fat content of coconut flour contributes to decreasing its cohesiveness and flowability [29]. Both variations retained a good amount of moisture that would make a poor shelf-stability life because high water retention in a product promotes mold spoilage [30].

Cookie strength

Measuring cookie strength is important because a hard, crumbly cookie is not an ideal product for an individual to consume. Cookie strength is synonymous with the tenderness of a cookie [31]. A lower force means that the cookie is very tender whereas a higher force translates into a harder cookie. Cookie breaking strength was similar for both cookie types (Table 6; $p > 0.05$). Similar values for cookies have been reported elsewhere [32], and these values represent cookies that are easily broken when chewed [32]. It is possible that fiber content explain the cookie tenderness. The cookies made with almond and coconut flours are a good source of fiber per serving, 2.0g and 4.2g, respectively. A study using sweet potato flour, a good source of fiber, in cookies indicated that the fiber content contributed to the tenderness of the cookies [32].

Nutrient content

Nutrient analyses were calculated to determine the macronutrient composition of samples. Results showed (Tables 7 & 8) that these cookies were balanced in protein (15 grams), total carbohydrates (8.5 grams cookie made with almond flour & 11.8 grams cookie made with coconut flour) and total fat (9.5 grams cookie made with almond flour & 6.8 grams cookie made with coconut flour). The protein content fits within the recommended range of intake for post-workout. However, depending on the intensity of the activity and the body composition of the athlete, the carbohydrates may be low compared to the recommended intake after activity. For example, a 200-pound (91kg) athlete would need to consume 109.2 grams (i.e., 1.2g of carbohydrates/kg body weight *91kg) of carbohydrates within 4 hours of activity. Thus, post-workout, 54.6 grams of carbohydrates would need to come from food. In order for an athlete to meet her carbohydrate needs, another carbohydrate source (i.e. banana) would need to be consumed concurrently with this cookie. However, the post-workout cookie's carbohydrate content is comparable to other standard cookie products on the market. For the cookies made with almond and coconut flours, the total fat content is high at 9.5 and 6.8 grams, respectively. However, both cookie types have a high percentage of mono and polyunsaturated fats compared to the total fat. Omega-3 polyunsaturated fatty acids are associated with reductions in inflammation. Both cookies are good sources of alpha-linolenic acid [25]. Thus, these cookies could reduce the pro-inflammatory responses known to happen among athletes' post-workout [6,11]. It is important that the nutrient content is competitive with other products to make athletes consider purchasing these cookies for a post-workout snack. Both formulations had little variation in nutrients with exception of the total carbohydrates and fiber. The cookies made with coconut flour had more carbohydrates than the almond. In addition, both formulations have low amounts of sugar, which is a factor that makes them competitive with other products on the market. Therefore, the cookie made with almond flour consumed post-workout may provide benefits to collegiate athletes.

Limitations

All the collected data was accurate and done in a proper manner, however, there were a few aspects that limited the accuracy of this

Table 7: Nutrient Content of Almond Flour Cookies per 100g (serving size 30g).

Ingredients	Calories	Total Fat (g)	Saturated fat (g)	Mono-unsaturated oils (g)	Poly-unsaturated oils (g)	Total Carbohydrates (g)	Fiber (g)	Sugars (g)	Protein (g)
Almond Flour (45086668)*	545	45.9	4.6	26.3	10.5	27.3	13.6	4.6	22.7
Oat Protein (per Tate & Lyle)	445	17	3	6.5	7.5	18	2	.4	54
Dannon Greek Yogurt (45223614)	47	0	0	0	0	7.1	0	7.1	4.7
Crisco Vegetable Oil (45255269)	857	100	14.3	21.4	29.8	0	0	0	0
Egg (45226336)	140	10	3	3.8	1.4	0	0	0	12
Vanilla Extract (45342793)	0	0	0	0	0	0	0	0	0
Monk Fruit Extract (45278135)	0	0	0	0	0	0	0	0	0
Total per 1 serving (30 g)	177	9.5	1	4	2.2	8.5	2	.7	15.6

*Note. Numbers in parentheses indicate nutrition information from USDA Food Composition Database.

Table 8: Nutrient Content of Coconut Flour Cookies per 100g (serving size 30g).

Ingredients	Calories	Total Fat (g)	Saturated (g)	Mono-unsaturated (g)	Poly-unsaturated (g)	Total Carbohydrates (g)	Fiber (g)	Sugars (g)	Protein (g)
Coconut Flour (per Hodgson Mills)	250	12.5	10	0	0	60	45	20	20
Oat Protein (per Tate & Lyle)	445	17	3	6.5	7.5	18	2	.4	54
Dannon Greek Yogurt (45223614)	47	0	0	0	0	7.1	0	7.1	4.7
Crisco Vegetable Oil (45255269)	857	100	14.3	21.4	29.8	0	0	0	0
Egg (45226336)	140	10	3	3.8	1.4	0	0	0	12
Vanilla Extract (45342793)	0	0	0	0	0	0	0	0	0
Monk Fruit Extract (45278135)	0	0	0	0	0	0	0	0	0
Total per 1 serving (30 g)	136	6.8	1	2.2	1.8	11.8	4.2	.4	15.3

Note. Numbers in parentheses indicate nutrition information from USDA database.

data. All 47 athletes were untrained taste testing panelists. Not one individual had any experience in training on how to taste for sweetness and crumbliness or evaluate appearance. Also, some participants indicated that they had never consumed a protein bar before, thus, they did not have a direct product for comparison. The taste test setting was not completely controlled. Some participants may have had distractions (talking with their peers) while they were evaluating the samples. Therefore, these components could have interfered with collecting accurate data.

Conclusions

After analyzing the results from all the sensory tests, the cookies made with coconut flour were slightly more preferred than cookies made with almond flour. This cookie had a better appearance and flavor. Nutrition value for this cookie was acceptable for a post-workout snack as it contained appropriate amounts of macronutrients. Athletes are different sizes and endure in different levels of activity. Depending on the athlete's nutrient needs, some may need to consume two of these cookies or pair it with another appropriate food source to obtain their nutrient needs.

Since the two variations were very similar, more research should be conducted to make the cookie made with coconut flour variation distinguishable from cookie made with almond flour variation. Other ingredients may need to be added to improve the texture, flavor and appearance. Reformulating the product would require another round of taste testing to receive additional feedback. In conclusion, the post-workout cookies have the potential to be an excellent post-workout snack for athletes, but it would need to undergo more research prior to selling these on the market.

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