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Preclinical Evaluation of the Consumption of High-Protein Vegetable-based Cookies

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INTRODUCTION AND AIM

Global interest in plant-based diets and functional foods is increasing due to their benefits for public health, the prevention of chronic diseases, and the reduction of environmental impact. In sports nutrition, innovative functional foods are essential to enhance performance, support recovery, and promote athletes' overall health. Protein-rich plant-based products offer a sustainable and ethical alternative to traditional sources; however, many still lack high-quality proteins and essential micronutrients, limiting their effectiveness for populations with high nutritional demands, such as athletes.

Develop a cookie made from chickpeas, carrots, broccoli, and soy milk, with a view to improving the protein content, fiber intake, and functional profile of the product.

These ingredients are notable for their bioactive compounds, vitamins, minerals, and complementary amino acid profile, which enhances the quality of the protein

Chickpea

Polyphenols, flavonoids, and saponins, with antioxidant and cell-protective effects, as well as B vitamins (B1, B6, and folate) and essential minerals such as iron, magnesium, zinc, phosphorus, potassium, and calcium.

Carrot

Carotenoids (β-carotene) and polyphenols, as well as vitamins A, C, and K, and minerals such as potassium, calcium, and phosphorus.

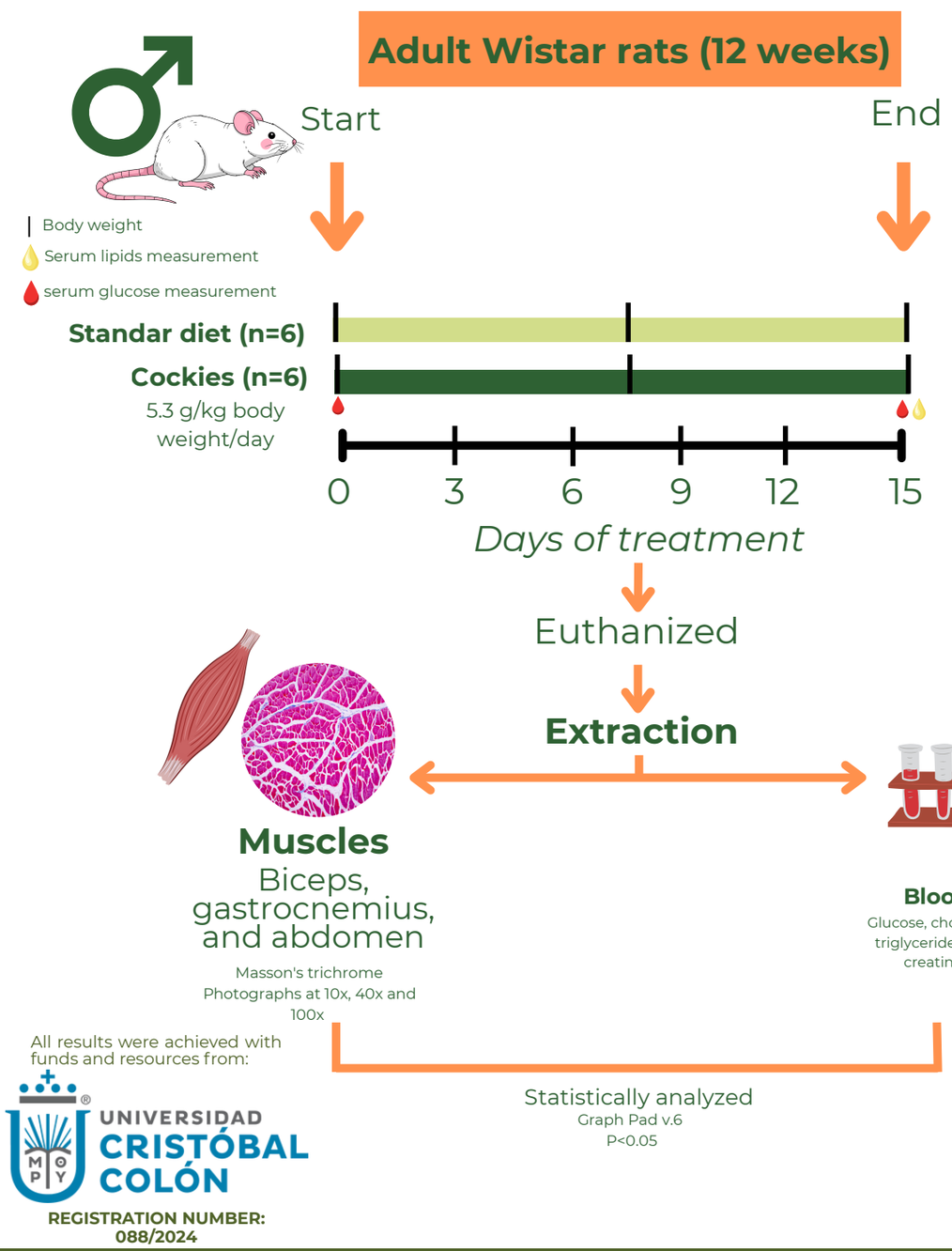
Broccoli

Sulforaphane, glucosinolates, and polyphenols, it provides vitamins C, K, A, and folic acid, as well as essential minerals such as calcium, potassium, phosphorus, iron, and magnesium.

Soy milk

Isoflavones (genistein and daidzein), as well as B vitamins and vitamin E, and minerals such as calcium, phosphorus, potassium, and magnesium

METHODS



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RESULTS AND DISCUSSION

Table 1. Nutritional composition of the cookies proposed..

Components	Cookies	Reference
Moisture	4.6 ± 0.2	AOAC 925.10
Crude protein	13.32 ± 0.5	AOAC 984.13
Crude fat	12.92 ± 0.3	AOAC 920.39
Ash	2.9 ± 0.1	AOAC 923.03
Crude fiber	6.78 ± 0.2	AOAC 962.09
carbohydrates (by difference)	65.89 ± 0.7	Indirect calculation
Energy (kcal/100g)	458.3 ± 10	Indirect calculation

Note: Carbohydrate content was calculated by difference. Total energy was estimated using the Atwater method (4 kcal/g for proteins and carbohydrates, 9 kcal/g for lipids).

Table 2. Biochemical parameters and body weight gain

Parameter	Estandar diet	Cookies
Body weight gain (g)	52.50 ± 2.2	53.64 ± 1.69 ns
Glucose (mg/dl)	85.17 ± 1.54	93.67 ± 1.61 ns
Cholesterol (mg/dl)	63.33 ± 0.51	61.28 ± 2.62 ns
Triglycerides (mg/dl)	46.34 ± 2.56	42.40 ± 1.90 ns
Urea (mg/dl)	40.12± 0.1	52.55 ± 2.74 *
Creatinine (mg/dl)	0.51 ± 0.01	1.04 ± 0.02 *
Uric acid (mg/dl)	1.0 ± 0.30	1.0 ± 0.39 ns

The data were analyzed using Student's t-test. ns indicates no significant difference. The asterisks represent the level of statistical significance: p < 0.05 (*).

This study preclinically evaluated a cookie formulation for athletes, characterized by a high protein content (13.32 ± 0.5 g/100 g), exceeding that of enriched commercial cookies. This effect was mainly attributed to the incorporation of chickpea flour, which also enhanced the essential amino acid profile. Additionally, chickpea flour improved the dough's technological properties, resulting in a denser and crunchier texture, highlighting the importance of optimizing ingredient proportions to balance nutritional quality and technological performance in the development of functional sports snacks. Also, it was also associated with an increase in urea and creatinine levels, suggesting a higher renal metabolic load.

The changes observed in muscle fibers suggest a structural adaptation of the muscle associated with protein intake, which could promote performance and recovery in the context of sports; however, as they are accompanied by an increase in urea and creatinine, they also indicate a greater metabolic and renal load, so these effects should be interpreted with caution when considering their application in athletes.

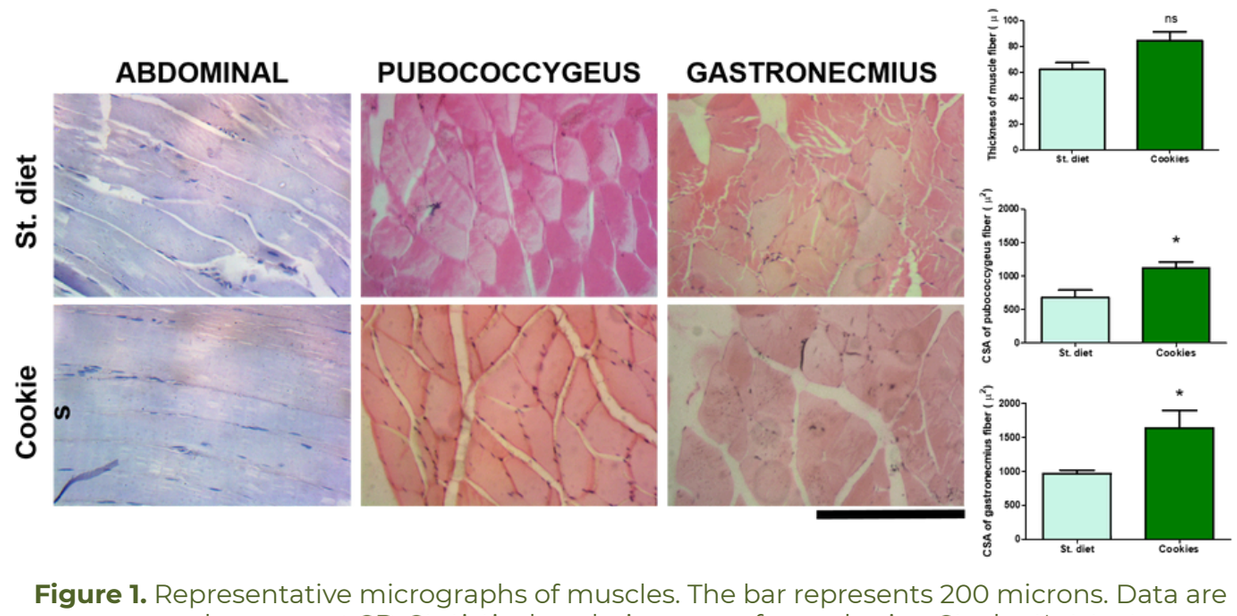

Figure 1. Representative micrographs of muscles. The bar represents 200 microns. Data are expressed as mean ± SD. Statistical analysis was performed using Student's t-test; ns indicates no significant difference and asterisks represent the level of significance ($p < 0.05$).

CONCLUSION

These findings suggest that consuming high-protein vegetable cookies is safe in preclinical settings and does not affect key biochemical markers. Their intake may promote functional improvements such as muscle strength and lean mass development, especially in males.

FUTURE WORK / REFERENCES

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