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Original Research

Effect of Plant Hybridization on the Nutritional Composition of Dairy Milk

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ABSTRACT: Milk is a basic source of food for all mammals including man. It is the sole source of nourishment for all mammals in the first phase of life; however, there have been raising challenges associated with the consumption of milk such as allergies like lactose intolerance, and high cholesterol levels, resulting in the search for plant based alternatives and hybrids to ensure nutritional balance. Milk was produced from a composite of bovine milk and water extracts of tigernut (*Cyperus Esculentus*) and soybeans (*Glycine max*) at a 4:3:3 ratio, and evaluated to establish nutritional value. Proximate analysis showed a moisture content of 83.41%, ash content of 1.35%, fibre content of 1.12%, fat content of 2.91%, protein content of 13.02% and carbohydrate content of 12.34%. Anti-nutritional content was determined to be 0.83% for phytate, 0.01% for tannin, 0.01% for oxalate, 0.31% for saponin and 0.02% for lectin, while mineral composition (mg/100ml) was determined to be 28.48 for calcium, 9.41 for magnesium, 3.97 for sodium, 2.42 for iron, 8.13 for potassium and 2.86 for zinc. The hybrid milk was determined to be nutritionally balanced.

Keywords: Dairy milk, plant hybridization, Cowmilk, Soymilk, Tigernut
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INTRODUCTION

Milk is a white liquid produced by the mammary glands of mammals. It is the primary source of nutrition for young mammals before they are able to digest other types of food (Willett and Ludwig, 2020). Milk is an emulsion of protein, fat, carbohydrate, minerals and vitamins in water (Martini *et al*., 2022). Early-lactation milk contains colostrum, which carries the mother's antibodies to the baby and can reduce the risk of many diseases in the baby Umar *et al*., 2023). As mammals grow, their sole dependencies on milk reduce until it becomes a complimentary source of nutrient. Generally, milk for complimentary feeding in older children and adults is gotten from mammalian animals like cows, buffalos, camels, sheep and goats (Toghdory *et al*., 2022). They all basically contain the same nutrients though in different quantities (Suh, 2022). There have however been rising problems associated with the consumption of milk. These include allergies such as lactose intolerance among those who lack the enzyme lactase required for its digestion, and high cholesterol content (Arasi *et al*., 2022). This has led to the search and discovery of plant alternatives (Makinen *et al*., 2016). Plant based milk has been developed and can be derived from the water extraction of legumes, nuts, grains and cereals. These alternatives are usually palatable and healthy, though they may be lacking in some basic nutrients (Rayburn *et al*., 2019; Chalupa-Krebzdak *et al*., 2018). The constituents of these products differ greatly depending on their source. Good sources of plant based milk in West Africa include soybeans and tigernut.

Soybean (*Glycine max*) belongs to a legume family *Poacea* and is an important edible crop for many people

Table 1: Proximate composition of bovine milk, tigernut milk, soyamilk and hybrid milk

SAMPLE	MOISTURE	ASH	FIBRE	FAT	PROTEIN	CHO
Cowmilk	80.05± 0.02^{d}	0.21±0.02^{d}	0.81±0.01^{d}	3.91±0.01^{a}	19.81±0.01^{a}	8.21± 0.02^{d}
Soymilk	84.05± 0.01^{b}	1.41±0.01^{a}	1.32±0.02^{b}	1.02±0.01^{c}	13.35± 0.01^{b}	18.36±0.02^{a}
Tigernut	86.31± 0.01^{a}	1.22±0.01^{c}	1.03±0.02^{c}	0.02±0.01^{d}	3.81± 0.01^{d}	10.23±0.02^{c}
Hybrid milk	83.41± 0.01^{c}	1.35±0.01^{b}	1.12±0.01^{a}	2.91±0.01^{b}	13.03± 0.02^{c}	12.34±0.01^{b}

Note: Figures represent mean values ±standard deviation. Means with the same superscript down the column are not significantly different.

all over the world (Vallath *et al*., 2022). It is one of the oldest sources of plant based alternative to dairy (Vallath *et al*., 2022). It is believed to be very nutritious with many bio-functionalities attributed to it (Elsami and Shidfar, 2019).

Tigernut (*Cyperus Esculentus)* plant is cultivated for its small tuberous rhizome which is eaten raw or roasted, pressed for its juice to make beverage or milk, extracted for non-drying oil or used as hog feed (Ogbonna *et al*., 2013). Its milk drink is believed to be a healthy alternative to animal milk (Opeyemi and Obuneme, 2020).

Hybrid animal and plant based milk has been proposed as a way of getting the best of two worlds (Accetta- Smith, 2021; Gerdes, 2023). The objective of this study is to produce and nutritionally analyze a hybrid bovine and plant based milk product.

METHODOLOGY

Sample collection

Tigernut (*Cyperus Esculentus* and soyabeans (*Glycine max*) were purchased from Uchi market in Auchi, Edo State. Fresh cow milk was purchased from cattle rearers in Auchi, Edo State, Nigeria.

Production process

Milk was produced using an equal ratio of 4:3:3 (Figure 1).

Determination of proximate composition

All proximate analysis was carried out using standard procedures as described by AOAC, (2012).

RESULTS AND DISCUSSION

The analyses show a balance in the nutritional composition of the hybrid product. Table 1 shows the proximate composition of bovine milk, tigernut milk, soyabean milk, and a hybrid of the three products. Results show that hybridization increased the moisture content of cow milk from 80.05% to83.41%, ash content from 0.21% to 1.35%, fibre content from 0.81% to 1.12% and carbohydrate content from 8.21% to 12.34%. High moisture content of food is indicative of the fact that microbes can easily proliferate in it (Zambrano *et al*., 2019), however it can also be a source of healthy hydration which is very essential (Papies, 2021). The ash content is indicative of the total mineral content of food (Afify *et al*., 2017), therefore the increase in ash contents means that hybridization generally increased the mineral content. Fibre in food has been proven to be a source of healthy and stable bowel function (Alava *et al*., 2019), therefore increase in dietary fibre of hybrid milk is beneficial. Carbohydrate is essential for energy generation and expenditure (Chem and Tan, 2019), and was adequately increased by hybridization. There was however a reduction in fat content from 3.91% to 2.91%, and protein content from19.81% to13.03%. There usually is a relationship between a high fat content and high cholesterol content, which are believed to increases the risk of chronic diseases (Zhao *et al*., 2019). A reduction in fat content of hybrid milk is therefore perceived as favourable. Though protein content reduced, it is important to note that plant protein is unique and its inclusion offers a healthy balance to the hybrid milk (Martínez-Villaluenga *et al*., 2020).

Anti-nutritional content generally increased for hybrid milk in relation to cow milk from being completely absent to 0.83% for phytate, 0.01% for tannin and 0.01% for oxalate. It also increased from 0.01% to 0.31% for saponin. Values however remained the same for lectin at 0.02%. Anti-nutrients are generally believed to hinder the absorption of some essential micronutrients (Lopez-Moreno *et al*., 2022), however, they are also believed to be a source of bioactive compounds (Lopez-Moreno *et al*., 2022), and are therefore okay at low levels (Table 2).

Though there was a reduction in mineral content of calcium, sodium, iron and potassium, of hybrid milk in relation to bovine milk, hybrid product maintained relatively high values. Values for magnesium and zinc however increased. Hybrid milk had a calcium content of 28.48mg/100ml, magnesium content of 9.41mg/100ml, sodium content of 3.97mg/100ml, iron content of 2.42mg/100ml, potassium content of 8.13mg/100ml and zinc content of 2.86mg/ 100ml (Table 3). Minerals are termed essential components in food and a deficiency

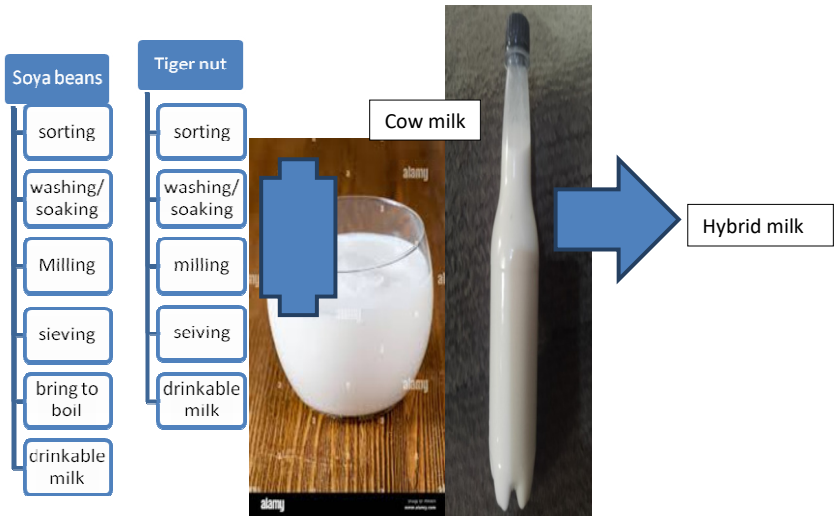

Figure 1: Systematic flow chart showing production of hybrid milk

Table 2: Anti-nutritional composition of bovine milk, tigernut milk, soymilk and hybrid milk.

SAMPLE	PHYTATE	TANIN	OXALATE	SAPONIN	LECTIN
Cowmilk	0.00± 0.00^{d}	0.00± 0.00^{d}	0.00± 0.00^{c}	0.01± 0.00^{d}	0.02± 0.00^{a}
Soymilk	1.74± 0.01^{a}	1.02± 0.00^{a}	0.20± 0.01^{a}	0.71± 0.01^{a}	0.01± 0.00^{b}
Tigernut	0.61± 0.01^{c}	0.03± 0.01^{c}	0.01± 0.01^{b}	0.22± 0.01^{c}	0.02± 0.00^{a}
Hybrid milk	0.43± 0.02^{b}	0.01± 0.01^{b}	0.01± 0.00^{b}	0.31± 0.01^{b}	0.02± 0.00^{a}

Note: Figures represent mean values ±standard deviation. Means with the same superscript down the column are not significantly different.

Table 3: Mineral composition of bovine milk, tigernut milk, soymilk and hybrid milk mg/100ml).

SAMPLE	Ca	Mg	Na	Fe	K	Zn
Cowmilk	36.45± 0.03^{a}	8.20 ±0.01^{c}	4.31± 0.01^{b}	2.91± 0.01^{b}	9.25± 0.01^{b}	1.31±0.01^{d}
Soymilk	24.61± 0.01^{c}	12.37±0.01^{a}	6.60± 0.01^{a}	3.38± 0.01^{a}	10.36± 0.01^{a}	3.72±0.02^{a}
Tigernut	16.32± 0.01^{d}	4.11± 0.02^{d}	2.14± 0.01^{d}	1.92± 0.02^{d}	6.63± 0.01^{d}	2.51±0.01^{c}
Hybrid milk	28.48± 0.02^{b}	9.41± 0.01^{b}	3.97± 0.02^{c}	2.42± 0.02^{c}	8.13 ±0.01^{c}	2.86±0.01^{b}

Note : figures are mean values ±standard deviation

can result in health challenges (Quintaes, 2015). Calcium is documented to improve bone health and control blood pressure related challenges (Cormick and Belizán, 2019). Potassium, iron and sodium intake are believed to affect cardiovascular activities and control blood pressures (Filippini *et al*., 2020; Sun and Weaver, 2021; Mente *et al*., 2021). Zinc is important in bone and soft tissue development (Ceylan *et al*., 2021). Magnesium is associated with incidence of stroke and diabetes (Zhao *et al*., 2020).

Conclusion

Dairy hybrids are blended products involving plant extracts being incorporated into dairy products. One can harness both products' taste and health benefits, offering the best of both to consumers while meeting evolving demands. It's crucial to recognize that the nutritional values of dairy products and plant based alternatives are not equal, but both can offer us key unique benefits. Plant-based diets are usually high in natural sources of dietary fibre whereas protein of higher quality is readily available in dairy (Walsh, 2019).

REFERENCES

Accetta-Smith P. (2021). Hybrid dairy products offer perfect combination. www.dairyprocessing.com

Afify, A. S., Abdalla, A. A., Elsayed, A., Gamuhay, B., Abu-Khadra, A. S., Hassan, M., ...& Mohamed, A. (2017). Survey on the moisture and ash contents in agricultural commodities in Al-Rass Governorate, Saudi Arabia in 2017. *Assiut Journal of Agricultural Sciences*, *48*(6),

55-62.
Alava, C., Verdú, S., Barat, J. M., Grau, R. (2019). Enrichment of chips with fibre from a tiger-nut (Cyperusesculentus) milk co-product at 'source of fibre foods' and 'high fibre content foods' levels: impact on processing, physico-chemical and sensory properties. *International Journal of Food Science & Technology*, *54*(3), 908-915.
AOAC (2012). Official methods of analysis. Association of official analytical chemist.22nd edition. Washington, D.C. pp. 35-60.
Arasi, S., Cafarotti, A., Fiocchi, A. (2022). Cow's milk allergy. *Current Opinion in Allergy and Clinical Immunology*, *22*(3), 181-187.
Ceylan, M. N., Akdas, S., Yazihan, N. (2021). Is zinc an important trace element on bone-related diseases and complications? A meta-analysis and systematic review from serum level, dietary intake, and supplementation aspects. *Biological Trace Element Research*, *199*, 535-549.
Chalupa-Krebzdak, S., Long, C. J., Bohrer, B. M. (2018). Nutrient density and nutritional value of milk and plant-based milk alternatives. *International dairy journal*, *87*, 84-92.
Cormick, G., Belizán, J. M. (2019).Calcium intake and health. *Nutrients*, *11*(7), 1606.
Elsami, O., Shidfar, F. (2019). Soy milk: A functional beverage with hypocholesterolemic effects? A systematic review of randomized controlled trials. *Complementary therapies in medicine*, *42*, 82-88.
Filippini, T., Naska, A., Kasdagli, M. I., Torres, D., Lopes, C., Carvalho, C., Vinceti, M. (2020). Potassium intake and blood pressure: a dose-response meta-analysis of randomized controlled trials. *Journal of the American Heart Association*, *9*(12), e015719.
Gerdes, S. (2023). Hybrid dairy/plant products promise better nutrition. *Dairy foods*.www.dairyfoods.com
Lopez-Moreno, M., Garcés-Rimón, M., Miguel, M. (2022).Antinutrients: Lectins, goitrogens, phytates and oxalates, friends or foe?. *Journal of Functional Foods*, *89*, 104938.
Martínez-Villaluenga, C., Peñas, E., Hernández-Ledesma, B. (2020).Pseudocereal grains: Nutritional value, health benefits and current applications for the development of gluten-free foods. *Food and Chemical Toxicology*, *137*, 111178.
Mente, A., O'Donnell, M., Yusuf, S. (2021). Sodium intake and health: what should we recommend based on the current evidence?. *Nutrients*, *13*(9), 3232.
Ogbonna, A. C., Abuajah, C. I., Utuk, A. R. (2013). Tigernut Milk: A Nutritious but Under Utilized Food Ingredient. *Food Biology*, *2*(2), 14-17.
Opeyemi, A. F., Obuneme, O. S. (2020). Bacteriological and nutritional assessment of tiger nut milk (kunun-aya) consumed by students of Nasarawa State University, Keffi Nigeria. *World Journal of Advanced Research and Reviews*, *6*(3), 059-068.
Papies, E. K. (2021). The psychology of desire and implications for healthy hydration. *Annals of Nutrition and Metabolism*, *76*(Suppl. 1), 31-36.
Quintaes, K. D., Diez-Garcia, R. W. (2015).The importance of minerals in the human diet. *Handbook of mineral elements in food*, 1-21.
Suh, J. H. (2022). Critical review: Metabolomics in dairy science-Evaluation of milk and milk product quality. *Food Research International*, 110984.
Sun, H., Weaver, C. M. (2021). Decreased iron intake parallels rising iron deficiency anemia and related mortality rates in the US population. *The Journal of Nutrition*, *151*(7), 1947-1955.
Toghdory, A., Ghoorchi, T., Asadi, M., Bokharaeian, M., Najafi, M., Ghassemi Nejad, J. (2022).Effects of Environmental Temperature and Humidity on Milk Composition, Microbial Load, and Somatic Cells in Milk of Holstein Dairy Cows in the Northeast Regions of Iran. *Animals*, *12*(18), 2484.
Umar, M., Ruktanonchai, U., Makararpong, D., Anal, A. K. (2023). Enhancing Immunity Against Pathogens Through Glycosylated Bovine Colostrum Proteins. *Food Reviews International*, 1-18.
Vallath, A., Shanmugam, A., Rawson, A. (2022). Prospects of future pulse milk variants from other healthier pulses-As an alternative to soy milk. *Trends in Food Science & Technology*.
Walsh M (2019) *Dairy alternatives - how do they compare?* Dairy Nutrition Forum.
Willett, W. C., Ludwig, D. S. (2020). Milk and health. *New England Journal of Medicine*, *382*(7), 644-654.
Zambrano, M. V., Dutta, B., Mercer, D. G., MacLean, H. L., Touchie, M. F. (2019). Assessment of moisture content measurement methods of dried food products in small-scale operations in developing countries: A review. *Trends in Food Science & Technology*, *88*, 484-496.
Zhao, B., Zeng, L., Zhao, J., Wu, Q., Dong, Y., Zou, F., ...& Zhang, W. (2020). Association of magnesium intake with type 2 diabetes and total stroke: an updated systematic review and meta-analysis. *BMJ open*, *10*(3), e032240.
Zhao, Z. H., Xin, F. Z., Zhou, D., Xue, Y. Q., Liu, X. L., Yang, R. X., Fan, J. G. (2019). Trimethylamine N-oxide attenuates high-fat high-cholesterol diet-induced steatohepatitis by reducing hepatic cholesterol overload in rats. *World journal of gastroenterology*, *25*(20), 2450.