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HIGH-PROTEIN CORN: A STAPLE OF A BALANCED DIET IN HAITI

Francois GUYVENCHY[1], Ciprian STROIA[1]
[1]University of Life Sciences "King Mihai I" from Timisoara
Corresponding author: ciprian.stroia@usvt.ro

Abstract. *Malnutrition remains a major public health problem in Haiti, especially among children under five years of age and pregnant women, due to limited access to a diversified and balanced diet. The Haitian diet relies heavily on cereals, especially maize, which is widely grown and consumed as a staple food. However, conventional maize has a low protein content and an unbalanced amino acid composition, particularly lysine and tryptophan, which contributes to the risk of protein malnutrition. This article aims to examine the potential of high-protein maize as a nutritional alternative for improving food security and feed quality in Haiti. The study builds on existing research on malnutrition, maize consumption and crop improvement, in particular the work of the International Maize and Wheat Improvement Centre (CIMMYT), which has developed improved maize varieties through breeding. A documentary and literature-based approach is adopted to analyze the nutritional limits of conventional maize and the potential benefits of high-protein maize in the Haitian context. The originality of this work lies in highlighting the importance of integrating nutritionally enriched maize into the Haitian food system, given the agricultural and dietary importance of this crop. Being said, this can help to improve protein intake, diversify nutritional resources and reduce the risk of protein deficiency in vulnerable populations. Its adoption could also support local agricultural development and enhance food security. Nevertheless, its effectiveness depends on factors such as seed accessibility, agricultural productivity, consumer acceptance and integration into practices.*

Keywords*: Malnutrition, Public health, Food security, Amino acid, Maize, Food system, Food security, Seed*

INTRODUCTION

An individual's diet largely determines his or her state of health (Amadou, 2011). Since ancient civilizations, the importance of a balanced diet was already in vogue. Indeed, the Greek doctor Hippocrates (5th century BC) asserted, "Make your diet your first medicine" (ANNE, 2015). Because a diet unbalanced can cause harmful effects on the body. This dietary imbalance can result on the one hand in overeating with negative consequences for health such as that obesity, diabetes, certain heart diseases and on the other side by undernourishment which leads to malnutrition by deficiency, commonly called undernutrition (ORGANIZATION WORLD HEALTH ORGANIZATION, 2006). Malnutrition is one of the most pressing global challenges. According to an FAO report published in 2013, about one in eight people suffer from malnutrition in the world.

In developing countries, like Haiti, this problem takes on a dimension particularly acute, affecting mainly children under 5 years of age. It is closely linked to infectious diseases and infant mortality. Despite the efforts made by the Haitian government, which devotes more than 14% of its annual budget to the fight against hunger and malnutrition (UNAG, 2012) the situation remains largely unchanged. Survey data EMMUS-V (2013) thus reveal that about one in eleven children dies before their fifth birthday birthday, while nearly 49% of pregnant women have deficiencies in micronutrients.

This situation is explained by both monotonous and and unbalanced feeding, as well as than by an imbalance between nutritional needs and available resources (MSPP, 2013).

Indeed, nearly 70% of Haitians are unable to eat properly, and their the diet relies almost exclusively on cereals, notably rice, maize and sorghum (UNAG, 2012). Among these, maize plays a central role: it is the most important crop widespread (CNSA, 2012) and constitutes, for

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many Haitians in particular the peasants main, even unique, source of daily nutrients (JEAN BAPTISTE, 2006). Yet, despite its massive consumption, maize remains low in protein and presents an unbalanced amino acid profile, with significant deficiencies in lysine and tryptophan (DROGOUL et al., 2004).

Such dependence on this cereal therefore exposes the population, especially rural, at an increased risk of protein malnutrition. Faced with this observation, the improvement of the nutrition in Haiti has become a top priority. To contribute to it, the International Centre for the improvement of corn and wheat (CIMMYT), based in Mexico, has developed by selection. We intentionally introduced a variety from the southern area of Muntenia, Wallachia, Romania, with a view to achieving a broader and more diversified scope. In these trials, the QPM varieties were compared with the local variety that was obtained from the Levy farm. Given what has just been highlighted, the present study is part of a perspective to assess the chemical composition of the grains of new varieties in order to help assess the potential of QPM maize in the fight against malnutrition in Haiti.

MATERIAL AND METHODS

The basic experimental material considered in this study consists of seven (6) high-protein corn varieties, of a European variety, more precisely from the Romania of the Corteva Agriscience seed plant and a local variety (Chicken Corn) grown in two different experimental sites (Lalouère and the Arcahaie plain). The seeds of Seven (7) varieties of high-protein maize have been produced by the Centro Internacional de Máys y Trigo (CIMMYT) in several different experimental centers and the seeds of the local variety came from the LEVY farm (Port-au-Prince-Haïti). The plant material used in this study was produced in two different areas in Haiti and one in Romania:

- Lalouère, fourth section, commune of Saint-Marc
- The plain of Arcahaie
- The plain of Muntenia

The adaptation essay conducted at Lalouère is part of a final year project carried out by student Jackson JEUDI under the supervision of Cindy ULYSSE ING.Agr. MSC and supported by the AKOSAA project. This communal section is located at 19° 07′ 00″ north latitude and 72° 42″ west longitude. It has a rainy season extending from June to November place from April to November (1,300 mm of rain/year) and a dry season that varies between November and May (220 mm of rain/year). The average temperature in the area is 27.9 °C (BAC de Saint Marc, 2013; 34 MARNDR, 2000). Soils come from the degradation of basaltic rocks, limestones and alluvium. Irrigable areas cover an area of 850 ha (MARDR, 2000) **.**

The experiment conducted in the plain of Arcahaie was also part of a final year project carried out by student Nikson PIERRE under the direction of Aloys NIZIGIYIMANA ING.Agr. MSC and Professor Tescar ROBERS-PIERRE ING.Agr. MSC of the FAMV. This zone is located at 18° 46′ 08″ north latitude and 72° 30′ 46″ west longitude. The average annual rainfall varies between 900 and 1000 mm with a rainy period extending from May to October and a dry period from November to March. The average annual temperature is around 27°C. This area shows very strong evaporation. It benefits from a more or less functional irrigation system (JULES and GUITO, 2009)

The trial of the Plain of Muntenie aims to give a broader and more diversified scope to this study. It is located in the south of Romania, extending mainly between 43°30′ and 45°30′ north latitude and 24°30′ and 27°00′ east longitude, in the heart of the Romanian plain (Ym Română). The annual rainfall varies between 500 and 700 mm, with a maximum in spring (April-May) and summers sometimes dry, contrasting with the neighboring mountainous areas. This

region, crossed by the Danube to the south and bordered by the Carpathians to the north and the Dobrudja hills to the east, enjoys a moderate continental climate, marked by Danubian and Balkan influences.

Table 1

List of varieties with their origin and characteristics

Species	Name of the Variety	Origin	Characteristic
	B00KLYZQUP	CIMMYT	High-protein corn
	B04KLYZQUP01	CIMMYT	High-protein corn
	B04KLYZQUP02	CIMMYT	High-protein corn
(*Zea mays* L.)	PIONEER 111 CRM	CORTEVA	Hybride Corn
	B09KLYZQUP05	CIMMYT	High-protein corn
	B07KLYZQUP04	CIMMYT	High-protein corn
	B07KLYZQUP03	CIMMYT	High-protein corn
	CHICKEN CORN	FERME LEVY (Haïti)	Normal corn

RESULTS AND DISCUSSIONS

Data from the chemical analysis of maize, carried out according to the methods mentioned earlier, are presented in the form of tables and graphs for each sample. The results of varieties grown only in the first trial will be included in the tables, but will not be taken into account in the comparisons of averages between the three areas studied. In accordance with the bibliographic references concerning the methods of dosing proteins in corn, we chose to retain the results from Dumas' method. The analyses obtained in this work were analyzed by the Dumas method described in the Materials and Methods part.

The results for protein content in corn samples are shown. The analysis revealed significant differences between the varieties. The protein content ranged from 8.33%, 9.45%, to 12.44%. The Chicken Corn variety recorded the highest content, with 12.13% in the first trial and 12.44% in the second. Conversely, the varieties B00KYZQU (9.45%) and B04KLYZQUP02 (9.64%), and Pioneer 111 (8.33%) had the lowest levels. The results indicate that the protein content was slightly lower for the varieties grown in the first zone compared to those grown in the second and third zones.

For example, the variety B00KLYZQU went from 9.45% (first zone) to 10.96% (second zone), as well as the hybrid variety Pioneer 111 by 8.33% (third zone). This trend is observed for all varieties. These differences could be explained by the influence of the environment, agricultural practices and nitrogen fertilization on grain protein content. These results demonstrated that the protein quality enhancing gene in QPM varieties mainly optimizes the amino acid profile, without guaranteeing a higher overall protein content.

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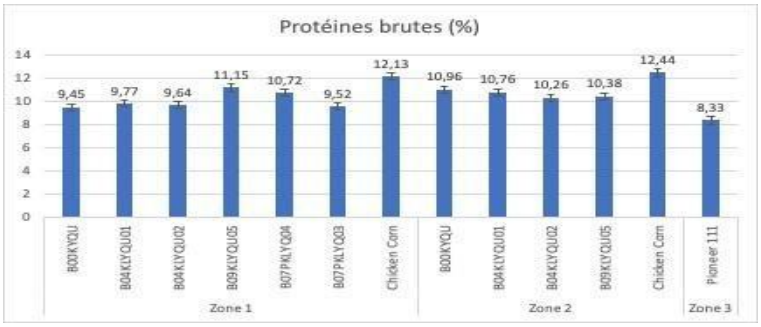


Figure 1. Distribution of protein content in maize varieties

These results demonstrated that the protein quality enhancing gene in QPM varieties mainly optimizes the amino acid profile, without guaranteeing a higher overall protein content. The analysis reveals a marked variation in starch content depending on the varieties studied. The strains B00KLYZQU, B04KLYZQUP01, B09KLYZQUP05 and B04KLYZQUP02 are distinguish by high rates, reaching up to 69.5%, while CHICKEN CORN records the lowest level (65.03%). But we can also observe that in the third zone, the value has a high rate.

However, despite these variations, none of the high protein value (QPM) varieties reached the protein level of the Chicken Corn variety. These results demonstrated that the protein quality enhancing gene in QPM varieties mainly optimizes the amino acid profile, without guaranteeing a higher overall protein content. It is therefore premature to state that the Chicken Corn variety has a higher protein value overall, because the nutritional quality of maize depends primarily on the amino acid composition of its proteins (FAO, 2013; PRASANNA, 2009).



Figure 2. Starch content of the varieties

Moreover, an inverse relationship is observed between the starch content and that of proteins, these two main components of the albumen (87.6% and 8%, respectively, according to FAO, 2010) being in competition. Thus, the increase of one is accompanied by a decrease of the

other, which has a direct impact on yield (DUDLEY et al., 2010). Based on these results, we can say that many factors can influence the performance of different varieties. The temperature, the climates to name only that. Higher temperatures during the grain filling phase can promote starch accumulation (faster synthesis of carbohydrates).

CONCLUSIONS

The objective of this study was to analyze the chemical composition of grains of six maize varieties QPM (Corn Protein Quality), from a hybrid variety grown in Europe mainly in the southern area of Romania and of a local variety, grown in two distinct agricultural environments in Haiti. Faced with the variability observed in QPM corn and to the specificities of the Haitian environment, and the particularity of the European context we have formulated the hypothesis that varietal testing would provide a better understanding the expression of the protein character of new varieties.

This study highlighted the potential of QPM maize varieties, in particular B00KLYZQUP, B00KLYZQUP05 and B00KLYZQUP02, whose high lysine content confirms their nutritional superiority in the two environments tested. These results validate our initial hypothesis and highlight the importance of varietal testing to assess protein character expression, especially in agricultural contexts as contrasted as those of Haiti and Romania. The local variety Chicken Corn, with its high protein content, also deserves special attention, as it could represent a local alternative adapted to the nutritional needs and conditions of haitian culture.

Indeed, as recommendations for the future, it is necessary to continue varietal testing by integrating more sites representative of Haitian conditions, to confirm the stability of the protein character of QPM varieties. Then make a complete evaluation of the nutritional value of promising varieties, in collaboration with specialized laboratories, to guide farmers' choices and agricultural policies. Then, to promote the adoption of QPM maize in Haiti, by supporting training and seed distribution programs, to make it an effective lever against malnutrition. Ultimately, this study opens up promising prospects for improving food security in Haiti, while highlighting the need for an integrated approach, combining varietal innovation, local adaptation and nutritional assessment.

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