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Review

Comprehensive quality and potential hazards of gowe, a malted and fermented cereal beverage from West Africa. A diagnostic for a future re-engineering

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ABSTRACT

Gowé is a very popular traditional fermented and non-alcoholic cereal beverage in Benin. The purpose of the present study was to characterize the physical-chemical properties, nutritional and anti-nutrient composition, microbiological safety and mycotoxin occurrence in the various types of gowé. Six to nine samples from four types of technologies were analyzed for the various aspects of quality. Proximate composition, physical properties (particle size, viscosity), nutritional (amino-acid profile) and anti-nutritional (tannin, phytate, and cyanide levels) properties of gowé resulting from the different traditional processes are quite similar except for the physical properties, the differences of which originate from the raw materials and the diverse cooking conditions. The main hazard of traditional gowé are potential mycotoxin contamination, and presence of cyanogenic compounds, which are linked to raw material contamination and the malting step, and occurrence of *E. coli* and Enterobacteriacae (gowé is free from other pathogens), linked to inappropriate handling and to the packaging material. The main defects are low α-amylase activity of malt linked to poor control of the malting process, low content of several essential amino-acids in the raw materials and which is deteriorated by the cooking step. Several potential solutions are discussed for paving the way for upgrading and re-engineering this process.

Contents

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1. Introduction

Gowé is one of the most popular traditional fermented and non-alcoholic cereal beverages in Benin. Like many African traditional products, it is of economic importance since it is relatively cheap to prepare and is therefore a viable alternative for low-income consumers who cannot afford imported or industrially processed foods (Abegaz, Beyene, Langsrud, & Narvhus, 2002). Gowé is mainly produced in the southern and central regions of Benin, but has spread to other regions due to intercultural interactions (Adinsi et al., 2014). It is sold as a paste produced from malted and non-malted sorghum (*Sorghum bicolor* (L.) *Moench*) and/or maize (*Zea mays*). It is consumed as a thirst quencher, and energy drink after dilution in water and the addition of sugar, milk and ice (Vieira-Dalodé et al., 2007). The peculiar nutritional and sensory properties of gowé derive from malting and fermentation. Its expansion to new market depends on its quality, which to date, varies considerably from one producer to another as well as between successive processing operations. Gowé is obtained after five to eight days of processing and some unit operations such as malting and fermentation are undertaken with weak control of the parameters (moisture, temperature, duration etc.). After processing, if stored at room temperature, gowé often spoils within 2–3 days due to the development of molds and an increase in acidity, and is then refused by consumers (Adinsi et al., 2014). To improve the quality and shelf-life of such traditional product, it is thus important to first characterize the diverse formulation and processing conditions (Demuyakor & Ohta, 1993) and the physico-chemical changes occurring during the process. Major efforts have already gone into the physical-chemical characterization of the main types of gowé (Michodjehoun-Mestres, Hounhouigan, Dossou, & Mestres, 2005) and the identification of the microorganisms involved in the fermentation (Vieira-Dalodé et al., 2007; Vieira-Dalodé, Madodé, Hounhouigan, Jespersen, & Jakobsen, 2008). However, to date the complete process has not been characterized, particularly the malting step, and neither the product nutritional properties nor its safety have been studied. Indeed, Hell, Cardwell, Setamou, and Poehling (2000) evidenced that 10–30% of maize grain samples collected in 300 farmers' stores in Benin were contaminated with aflatoxin at levels higher than 5 ppb and Murashiki et al. (2017) reported that aflatoxin B1 and fumonisin B1 are both widespread contaminants of maize in African countries such as Zimbabwe. These contaminations can lead to rapid deterioration of the resultant food product, hence lower shelf life (Hell et al., 2000; Temba, Njobeh, & Kayitesi, 2017). About 40% of the reduction in life expectancy in developing countries is associated to the mycotoxins in the food consumed by the populations (FAO, 2005). The nutritional properties of gowé also depend on anti-nutritional factors, i.e. cyanide in the malt, and phytate and tannin, which have been reported in other malted-fermented products (Kayode, Hounhouigan, & Nout, 2007; Muyanja, Birungi, Ahimbisibwe, Semanda, & Namugumya, 2010). In addition to sorghum gowé, which has been partially studied (Michodjehoun-Mestres et al., 2005; Vieira-Dalodé et al., 2007, 2008) maize gowé, mixed sorghum-maize gowé and steam-cooked maize gowé were reported in a recent survey in central Benin, which differs both in the raw materials and the processing technology as a result of innovative actions by producers (Adinsi et al., 2014). These types of gowé have not yet been documented. The change in raw materials (maize alone or combined with sorghum), the length of germination and of fermentation influence the quality of the product. To our knowledge, no validated information has been published on these new processing methods and on the characteristics of derived products. The purpose of the present study was thus to characterize the physical-chemical properties of the raw material, of the intermediate products and of the final products and to fill the gap in knowledge concerning the global quality, the nutritional composition and the potential hazard of these new types of gowé. A complete diagnosis of all quality aspects is provided for the different technologies used for the production of traditional gowé, thus paving the way for upgrading and re-engineering this process.

2. Material and methods

2.1. Sample collection

2.1.1. Malt samples

Seven sorghum and six maize malt samples were collected from gowé processors. These samples were ground using a disc attrition mill for the determination of amylase activity, phytate, cyanide, and tannin contents.

2.1.2. Commercial gowé samples

Twenty-seven (27) gowé samples from four processes (9 sorghum gowé, 6 maize gowé, 6 mixed sorghum-maize gowé and 6 steam-cooked maize gowé) were collected at major markets in Zou-Collines (central Benin) in individual sterile bags, placed in an ice-box containing ice, and transported to the laboratory. Subsamples were immediately taken for microbiological analysis, pH, titratable acidity, viscosity and particle size. The remainder was stored at −20 °C or freeze-dried for subsequent analyses.

2.1.3. Extra samples

In addition, six samples (3 raw materials and 3 final products) were collected from processors to evaluate if amino-acids and mycotoxin level were modified by the process.