

# Application of Modified Cassava Flour on Restructured Meat Product: A Review

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**Abstract.** Modified cassava flour is a derivative product obtained through the fermentation of cassava roots, which are rich in carbohydrates and possess high nutritional value. The modification process improves its functional properties, making it suitable as an additive in various food products, particularly in restructured meat. Restructured meat refers to products in which small meat pieces, trimmings, or granules are combined and processed to form larger, uniform portions that resemble whole cuts of meat. This method not only maximizes the utilization of raw materials but also enhances economic efficiency in meat processing. Modified cassava flour is used as a filler or binder, improving the cohesiveness, texture, and overall quality of the final product. This study reviews the utilization of modified cassava flour in restructured meat products. Furthermore, the study summarizes recent research findings regarding the incorporation of modified cassava flour in diverse restructured meat products. In beef patties, substituting bread crumbs with mocaf flour, even up to 75%, has been shown to decrease pH, cooking weight loss, and water content while increasing tenderness. The addition of modified cassava flour increased the water content in chicken nugget whereas its application in meat sausages, with a ratio of modified cassava starch to mocaf of 80:20 being preferred for taste and texture. The discussion also addresses the benefits, potential challenges, and future development opportunities of using modified cassava flour, thereby offering valuable insights and serving as a reference for further innovations in the field of meat product processing and functional ingredient application.

**Keywords:** modified cassava flour, products, restructured meat

## 1 Introduction

Modified cassava flour (mocaf) is produced by fermenting cassava chips with selected microbial cultures, which partially degrade cell walls and alter starch structure to yield a flour with different functional properties than native cassava flour [1]. The fermentation step increases resistant starch fractions and can change the balance between rapidly digestible and slowly digestible starches, so mocaf often contains measurable resistant starch that contributes dietary-fibre-like benefits. Fermentation also tends to increase water-holding and oil-binding capacities relative to some native starches, which improves MOCAF's behavior

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in batters, doughs, and restructured products [2]. Because microbial action loosens the granule surface and creates pores, mocaf granules typically show more porous or cracked surfaces under microscopy, and that morphology affects hydration and pasting behavior. The paste stability of mocaf during heating is commonly improved, with lower breakdown viscosity and higher final viscosity in many samples, so products made with mocaf are often more thermally stable in processing. mocaf chemical composition (moisture, ash, protein, lipid, carbohydrate) depends on the cassava variety and processing details, so proximate values should be measured for each source when formulating foods. Because mocaf is gluten-free and can mimic some functional roles of wheat flour, it is an attractive ingredient for gluten-free and cost-saving formulations, especially where cassava is abundant.

Fermentation time and the choice of cassava cultivar are two primary factors that determine mocaf's final physicochemical and functional profile, with short fermentations sometimes increasing resistant starch and mid-range fermentations improving paste stability, while extended fermentation can reduce total starch by enzymatic hydrolysis [2]. Different cultivars (for example, locally used sweet versus bitter types) present distinct starch structures, amylose/amylopectin ratios, and granule sizes, all of which interact with fermentation to produce unique mocaf behaviors in water uptake, swelling power, and gelatinization temperature [1]. Empirical studies show that moderate fermentation can raise resistant-starch content and generate surfaces on granules that increase solubility and water absorption, but prolonged fermentation often increases depolymerization and decreases total starch and resistant fractions. Thermal properties measured by DSC (onset, peak, endset temperatures, and enthalpy) shift with both cultivar and fermentation: some mocaf samples display higher gelatinization temperatures and altered enthalpy values compared with native starch, reflecting crystalline reorganisation during processing. Rheological measurements (storage and loss moduli,  $\tan \delta$ ) likewise vary: mocaf gels generally show more elastic ( $G' > G''$ ) behavior and greater hot-paste stability than unmodified cassava starch, but the magnitude depends on cultivar and fermentation time. Because these parameters affect processing (mixing, extrusion, baking, frying), optimizing fermentation time for a chosen cultivar is essential when targeting a specific application such as noodles, crackers, or restructured meat analogues. In practice, formulators should therefore pilot mocaf from the intended cultivar and fermentation schedule to match the functional profile required by the end product [3].

Mocaf's enhanced paste stability, water-holding capacity, and variable resistant-starch content make it suitable across several food categories: gluten-free bakery, extruded snacks, noodles, restructured protein products, and functional baked goods where moisture retention and texture stability are priorities. In bakery and pastry, mocaf can partially replace wheat flour to reduce import dependence while preserving acceptable texture when combined with hydrocolloids or protein enrichers to compensate for gluten's structural role [3]. For restructured meat and analogue formulations, mocaf acts as a filler and binder improving yield and mouthfeel, but it is often combined with hydrocolloid gels (e.g., konjac/carrageenan) or plant proteins to obtain the desired gel strength and WHC [4-5, 6]. In gluten-free pasta or noodles, mocaf contributes appropriate viscosity and gelation when process conditions (pH, hydration, drying) are matched to the mocaf's measured pasting and thermal profiles. From a nutrition and product-design perspective, higher resistant-starch mocaf enables claims around lower glycemic response and prebiotic potential when supported by analysis and labelling, but developers must control fermentation and drying to stabilise RS levels [6]. Finally, because cultivar, fermentation regime, and downstream drying/sieving all influence mocaf performance, routine characterization (proximate, RVA/DSC, rheology, SEM) is recommended during scale-up to ensure consistent end-product quality and to select the most suitable mocaf batch for each application.

This review focuses on the different used for mocaf on restructured meat product, the effect of the addition, and the impact of mocaf on the properties of restructured meat products.

## 2 Materials and Methods

Materials used in this literature review are article from publisher and website such as google scholar, sciencedirect, springer and published within 6 years prior. The article that used includes experimental research article, proceeding, and literature review. The methods used are literature review using article that based on the similar topic which is the usage of modified cassava flour on restructurd meat product. Based on the research that have been conducted there are three restructured animal meat product that used modified cassava flour in the making process. Those products are patty, chicken nugget and sausage.

## 3 Discussion

The details of various restructured meat products are detailed below.

### 3.1 Patty

A patty is a shaped, typically flattened portion of restructured meat made by binding comminuted or separated muscle pieces, fat, and functional ingredients into a cohesive single-piece product for direct cooking and consumption [8]. It is characterized by a uniform shape and size, a texturally consistent bite that mimics whole-muscle cuts, enhanced sliceability or form-holding during cooking, and often improved juiciness and flavor through added binders, salts, and water-holding agents. Its microstructure shows redistributed muscle fibers and protein networks formed during comminution and subsequent binding processes, with fat dispersed to provide lubrication and sensory fat-melting during cooking [9]. The underlying principle is to recover and recombine meat fragments using mechanical processing, protein extraction (salt and pH effects), and binding agents (phosphates, starches, or modified flours) so that proteins form a continuous gel-matrix that traps water and fat when heated, producing a stable, sliceable structure [10]. Patty manufacture therefore balances formulation (binders, fillers, fat), processing (mixing, forming, and thermal treatment), and quality targets (yield, texture, juiciness, sensory acceptability) to produce a consistent restructured meat product.

Beef patties reviewed show that substituting mocaf (modified cassava flour) for breadcrumbs lowers moisture content and cooking loss while decreasing product pH, with formulations around 50–75% mocaf producing significant reductions in cooking loss and a more tender texture compared with the control. Adding mocaf increases water-holding capacity relative to the amount used but promotes a denser gel structure that, at very high concentrations ( $\geq 100\%$  mocaf), leads to increased hardness and less desirable texture. Nutritionally, mocaf is relatively low in fat and has slightly higher protein and ash than plain tapioca, so patties containing mocaf tend to show a relative reduction in fat and a modest increase in the protein/ash fraction in the final product. Changes in mocaf starch composition (amylose/amylopectin) and its gelatinization behavior explain the observed reductions in cooking loss and measurable textural changes. Functionally, mocaf is recommended as a filler to replace breadcrumbs in patties up to a certain ratio (e.g., 50–75%) to optimize cooking loss and the nutritional profile [10]. According to the physical quality of patty, the

best formulation is by using 25% of breadcrumbs and 75% of mocaf with the results are shown in Table 1.

**Table 1.** Physical quality of beef patty with 75% mocaf substitution

Physical Quality	Value
Water Content	67.78 %
pH	6.45 %
Cooking Loss	26.50 %
Tenderness	0.00562 N

### 3.2 Chicken Nugget

A chicken nugget is a comminuted and restructured poultry product made by cutting or mincing deboned chicken, blending it with seasonings, functional ingredients (binders, salts, starches, phosphates), forming into small uniform shapes, coating with batter or breadcrumbs, and then frying or baking to set the exterior crust. Characteristic features include a cohesive myofibrillar protein gel that binds water and fat for juiciness, a fine and uniform internal texture from particle size reduction, high yield and sliceability due to added binders and starches, and a crisp, golden outer coating that provides the expected crunchy contrast [14]. The fundamental processing principle is extraction of salt-soluble myofibrillar proteins during comminution and mixing, which upon heating form a gel network that entraps fat and water and stabilizes the nugget structure. Formulation and processing variables—raw material quality, comminution intensity, binder type and level, salt and phosphate concentration, and cooking/frying conditions—determine water-holding capacity, texture, flavor retention, and coating adhesion. Optimizing these factors allows manufacturers to balance yield, sensory quality, and shelf stability while enabling cost-effective inclusion of extenders or functional flours when desired [15].

Partial replacement of wheat flour with mocaf (in composite formulations MOCAF:brown rice:cornstarch = 4:1:3 or wheat substitution levels of ~20–60% mocaf) produced products with variable moisture but several formulations showed increased moisture and markedly higher crude fiber, while fat remained low and protein stayed high due to added isolated soy protein and chicken meat. The composite-filler formulation preferred by panelists delivered proximate values of roughly 57–58% moisture, low fat (~1–1.6%), very high protein (~29% in the composite study), increased ash in some substitutions, and substantially elevated crude fiber (>16%) depending on adjuncts such as carrot and brown rice. Nutritionally, mocaf contributes fiber and ash while its fermentation reduces starch complexity, slightly lowering measured carbohydrate and improving digestibility. The relatively high moisture in some formulations requires process control (e.g., frying/draining) to ensure microbial safety and the desired final texture. Therefore, partial substitution of wheat with mocaf (commonly 20–40% or used as the dominant component within a balanced starch blend) can lower fat, raise fiber, and maintain or increase protein content in chicken nuggets. The result of chicken nugget quality according to chemical and organoleptic characteristic are shown in Table 2 and Table 3 [11].

**Table 2.** Chemical characteristics of chicken nugget based on composite flour

<b>Chemical characteristics</b>	<b>Value</b>
Water content	57.55%
Fat content	1.05%
Ash content	1.95%
Protein content	29.19%
Crude fibre	16.06%
Carbohydrate (by difference)	10.220%

**Table 3.** Organoleptic characteristics of chicken nugget based on composite flour

<b>Organoleptic characteristics</b>	<b>Value</b>
Color	2.83
Scent	2.97
Texture	2.70
Flavor	2.53

### 3.3 Sausage

Sausage is a restructured meat product made by comminuting meat and mixing it with non-meat ingredients such as salt, spices, curing agents, and functional additives to form a cohesive matrix. Its key characteristics include uniform texture, enhanced water-holding capacity, and improved binding due to the incorporation of proteins and hydrocolloids. The principle behind sausage formulation relies on solubilizing myofibrillar proteins through salt and mechanical action, which enables emulsion formation and gelation upon cooking. This restructuring allows for the utilization of lower-value meat cuts while achieving desirable sensory and nutritional properties. Sausages can be fresh, cooked, or fermented, with each type requiring specific processing conditions to ensure safety, stability, and quality [13].

Analog sausages based on corn starch and moringa flour with added mocaf and porang flour, inclusion of mocaf (reported in formulations containing 22% mocaf and 3% porang among variations) significantly raised crude fiber in the product (values ≈11–14%) and increased protein relative to a starch-only control because of moringa’s contribution, with a small rise in ash attributable to mocaf. Mocaf functions as a natural binder/gelling agent similar to STPP when combined with porang (glucomannan), yielding a firmer, more cohesive texture and moderate water retention; the best-performing formulation measured ~62.6% moisture, ≈2.09% protein (for a meatless analog), ~1.00% ash, and ~11.35% crude fiber. Nutritionally, this combination reduces the proportion of pure starch (carbohydrate) while increasing dietary fiber and mineral fractions, making the product more functional, though absolute protein depends on moringa and other protein sources in the recipe. In summary, mocaf in analog sausages effectively increases fiber and mineral content and serves as a functional binder when paired with porang and moringa at appropriate ratios [12].

## 4 Conclusion

The use of modified cassava flour (mocaf) in restructured meat products consistently enhances nutritional value, particularly by increasing dietary fiber and reducing fat content. In beef patties, mocaf substitution lowers cooking loss and improves tenderness, although excessive use may lead to undesirable hardness. For chicken nuggets, mocaf contributes to higher protein and fiber levels while maintaining acceptable sensory qualities when

combined with other flours. In sausage formulations, mocaf acts as a natural binder, boosting fiber and mineral content while supporting texture development. Overall, mocaf serves as a functional and health-promoting ingredient across diverse meat analog applications when used at optimal ratios.

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