

# Cissus Populnea Flour Addition and Proximate Composition, Functional and Sedimentation Properties of Millet Kunu

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Received: 28 December, 2018; Accepted: 28 February, 2019; Published: 15 March, 2019

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## Abstract

The study evaluated the possibility of using *cissus populnea* mucilage flour as a colloid in beverage production and its influence on proximate composition, functional properties and sedimentation rate of millet kunu during storage at ambient temperature. Hot water (80 - 90 °C) extraction method was used to extract the mucilage from fresh stem cuttings of *cissus populnea* plant. Freeze (100g, -40°C, 48 hr) drying method was used in mucilage flour production. Standard methods were used in millet-cissus kunu production and determination of the proximate composition, functional properties and sedimentation rates of the beverage samples. Results showed that addition of freeze dried *cissus populnea* mucilage flour to millet kunu significantly decreased its moisture content but increased its protein, fat, fibre, ash and carbohydrate contents, when compared to 100% millet kunu (control). Similarly, the addition of freeze dried *cissus populnea* mucilage flour to millet kunu significantly elevated the viscosity, pH, and tritratable acidity of the beverage samples when compared to control. The addition of *C. populnea* mucilage flour to millet kunu equally reduced the rate of dissociation of the starch granules from the beverage during 8 hr storage at ambient temperature. Freeze dried *C. populnea* mucilage flour has the potentials of serving as a colloid in beverages and improving its nutritional and functional attributes.

**Key words:** *Cissus populnea*; kunu beverage; hydrocolloids; homogeneity; natural gums; sedimentation rate

## Introduction

Kunu beverage is an excellent source of carbohydrate, minerals and vitamins. Kunu a cereal based non-alcoholic fermented beverage is widely consumed in northern Nigeria. After production however, starch molecules of the cereal(s) used tend to dissociate from water in which they are held in suspension forming a two layer beverage product lacking in homogeneity. Though the consumption of kunu beverage continues to increase in Nigeria, however, the formation of sediment in the beverage is one of the major reasons some consumers reject it. Additionally, the sediment can adversely influence the quality of beverage by absorbing flavour substances. Sediment velocity relies on the particles' diameter and density, the density and viscosity of the solution. Reduction of particle size and incorporation of polysaccharide stabilizers or soluble dietary fibres are simplified means for solving the problem of beverage sedimentation.

Hydrocolloids have been used in improving cloud stability in beverage production, however, this is limited by quantity of hydrocolloids added, type of beverage product and production process adapted [1]. High quantity of hydrocolloids addition impacts adversely on texture quality of products. Hydrocolloids are important groups of polysaccharides, generally characterized by high molecular weight [2]. As food gums, they are used to improve mouth feel and to change the viscosity of solutions due to their high polymeric nature and the interactions between polymer chains when they are dissolved or dispersed [3].

*Cissus populnea* mucilage flour when used as soluble dietary fiber has important nutritive component for human health, due to its various physiological functions. Fresh *Cissus populnea* mucilage is extremely viscous giving rise to liquid products with high viscosity. Foods with high viscosity decrease protein efficacy and lipid utilization by interfering with the digestion and absorption of nutrients [4, 5, 6]. When high viscose foods are dissolved in water, they tend to slow gastric emptying [7]. Alfa et, al. reported that cissus gum has very high water-absorption and swelling capacities, becoming both pseudoplastic and thixotropic in an aqueous solution of at least 4 % w/v. As an emulsifying agent, cissus gum would perform better as an emulsion stabilizer than as emulsifying agent in comparison with gum arabic [8, 9]. In another study, confirmed cissus gum as an emulsion stabilizer [10]. *Cissus populnea*(Gull and Perr) is a savannah shrub and climber which can reach height of three meters or more depending on the supporting tree and its age [11]. It is an under-utilized edible gum grown in the middle belt of Nigeria, where it has long found a place in the traditional menu of Tiv, Idoma and Igala ethnic groups [12, 13]. It is called Ager in Tiv, Okoho in Idoma and Igala, Dafara in Hausa and Ogbolo in Yoruba languages in Nigeria [14]. The demulcent property, biocompatibility, cheapness, lack of toxicity, soothing action and non irritant nature of cissus gum favours its wide usage in several industries. In the food industry its viscose property enables it to be employed as hydrocolloid and soup thickener, its gelling/thickening property in the production of jam, jelly, marmalades, dairy products and salad dressings while its binding/coating property in the production of baked

foods [15]. Also, there has been great interest in the medicinal application of cissus mucilage as tablet binding agent [16, 17, 11]. This work evaluated the effect of *Cissus populnea* mucilage flour incorporation in beverage production on the proximate composition, functional and homogeneity properties of millet kunu.

## Material and Methods

### Source of materials

Fresh *Cissus* stems were harvested from University of Agriculture, Makurdi forest. Millet (*Pinnesetum nigritarum*) grains, dry sweet potato chips, malted rice and dried ginger were purchased from Wurukum market, Makurdi Local Government Area, Benue State, Nigeria. The harvested stems were packed into clean polyethylene bags and transported to the Food Preparation Laboratory, Department of Home Science and Management, University of Agriculture, Makurdi for processing.

### Preparation of *Cissus populnea* mucilage and flour

The stems were cut to 30 cm long, scrapped, washed, peeled, shredded and soaked in hot distilled water (90 °C/10 min), kneaded/squeezed (10 min) and filtered (muslin cloth) to produce mucilage. The mucilage (100g) was thereafter frozen (-400C, 5 min), freeze dried for 48 hr (Vacuum freeze dryer/lyophilizer, model S020, China) while the resulting cake was milled into flour using kitchen blender (Sonik, model SB-735, Japan).

### Preparation of millet kunu

Millet kunu was produced by steeping (12 hr), wet milling, gelatinizing, cooling, adding/mixing sweetener paste, portioning (100, 95, 90, 85, 80, 75g), adding *Cissus* flour (5, 10, 15, 20, 25g) to 95, 90, 85, 80, 75g millet kunu, respectively and stirring (wooden stirrer) to obtain millet-cissus kunu.

### Proximate analysis

The moisture, crude protein, total fat, ash and crude fibre were determined according to Association of Official Analytical Chemists method, while carbohydrate was calculated by difference [18, 19].

### Functional properties

The viscosity of the millet-cissus kunu samples were analyzed according to method, total titratable acidity according to method while pH was determined according to method using a pH meter with a glass electrode (Model 82- 63, Orion Research, Inc., Beverly, MA) [18, 20, 21].

### Sedimentation characteristics

Sedimentation rate was determined by method [22].

### Statistical analysis

Data for all determinations were subjected to analysis of variance (ANOVA) while differences among means were separated using Duncan's New Multiple Range Test [23].

## Results

### Proximate composition of millet cissus kunu

The proximate composition revealed that millet kunu (control) had higher (91%) moisture content than millet-cissus kunu samples (88.82 - 87.53%), which decreased with every 5% increase in *cissus populnea* flour addition (Table 1). The protein, fat, fibre, ash and carbohydrate contents of millet-cissus beverage were enhanced by 0.02-0.03%, 0.01-0.05%, 1.66-1.69%, 0.30-1.63% and 1.03-1.60%, respectively with every 5% addition of *cissus populnea* flour. The protein, fat, fibre, ash and carbohydrate contents of millet-cissus kunu samples were higher than millet kunu, respectively.

**Table 1:** Proximate composition of millet-cissus kunu (%)

Samples	Moisture	Protein	Fat	Fibre	Ash	Carbohydrate
A (100:0)	91.00±1.44p	0.25±0.01s	0.03±0.01s	0.45±0.01s	0.17±0.01s	7.12±0.01s
B (95:5)	88.82±0.46s	0.27±0.02s	0.04±0.01s	2.11±0.01p	0.47±0.03s	8.15±0.07p
C (90:10)	88.15±0.71s	0.28±0.01p	0.05±0.01s	2.11±0.01s	0.62±0.02s	8.65±0.03p
D (85:15)	87.89±0.55s	0.28±0.03s	0.06±0.02s	2.11±0.01p	0.85±0.01s	8.74±0.01p
E (80:20)	87.69±0.27s	0.27±0.02s	0.05±0.02s	2.11±0.01p	1.01±0.01s	8.68±0.07p
F (75:25)	87.53±0.04s	0.27±0.01s	0.08±0.01p	2.24±0.01p	1.80±0.01p	8.72±0.02p
LSD	17.7	0.05	0.01	0.37	0.72	1.67

Mean ± SD triplicate determinations. Means with same alphabets in a column are not significantly ( $P<0.05$ ) different

A (100:0) = 100% millet kunu

B (95:5) = 95% millet kunu and 5% cissus flour

C (90:10) = 90% millet kunu and 10% cissus flour

D (85:15) = 85% millet kunu and 15% cissus flour

E (80:20) = 80% millet kunu and 20% cissus flour

F (75:25) = 75% millet kunu and 25% cissus flour

### Functional properties of millet-cissus kunu

The functional properties of millet-cissus kunu are presented in (Table 2). The result indicated that millet-cissus kunu with 25% *cissus populnea* flour addition had higher (918.53%) viscosity value while millet kunu (control) had the least (575%) viscosity index. The viscosity of millet-cissus kunu samples increased

with increase incorporation of *cissus populnea* flour. Millet kunu (control) had a near neutral pH (6.43) value while millet-cissus kunu samples containing 20% and 25% *cissus populnea* flour were more acidic (5.55 pH). The titratable acidity of millet-cissus kunu samples however, increased (0.540 - 0.380) with every 5% increase in *cissus populnea* flour.

**Table 2:** Functional properties of millet-cissus kunu

Samples	Viscosity (%)	pH	Titratable acidity (g/ml)
A (100:0)	575.00±35.36s	6.43±0.03p	0.540±0.005s
B (95:5)	620.82±28.28s	5.49±0.01s	0.530±0.005s
C (90:10)	675.15±7.07s	5.49±0.01s	0.440±0.005p
D (85:15)	773.89±4.24s	5.53±0.01s	0.410±0.005p
E (80:20)	840.69±56.57s	5.55±0.02s	0.380±0.005s
F (75:25)	918.53±25.45s	5.55±0.01s	0.390±0.005s
LSD	146.7	1.13	0.09

Mean ± SD triplicate determinations. Means with same alphabets in a column are not significantly ( $p < 0.05$ ) different

A (100:0) = 100% millet kunu

B (95:5) = 95% millet kunu and 5% cissus flour

C (90:10) = 90% millet kunu and 10% cissus flour

D (85:15) = 85% millet kunu and 15% cissus flour

E (80:20) = 80% millet kunu and 20% cissus flour

F (75:25) = 75% millet kunu and 25% cissus flour

### Sedimentation characteristics of millet-cissus kunu

The sedimentation characteristics of millet-cissus kunu samples in the first 4 hr of storage at ambient temperature are presented in Figure 1. The sedimentation rates indicate that millet-cissus kunu with 20% *cissus populnea* mucilage flour had highest colloidal properties exhibiting no dissociation of starch granules in the first 1.5 hr of storage at ambient temperature, with a 1 – 3 ml dissociation of starch granules in the remaining 2.5 hr of the first 4 hr storage period. It was followed by sample 75:25 with starch granules dissociation values of 0, 0, 1, 2, 2, 4, 4 and 4 ml at 0.5, 1, 1.5, 2, 2.5, 3, 3.5 and 4 hr, respectively. The control (100% millet kunu) had the highest rate of starch granule dissociation 0 (0.5 hr), 2 ml (1 hr), 2 ml (1.5 hr), 2 ml (2hr), 4ml (2.5 hr), 6 ml (3 hr), 7 ml (3.5 hr) and 7 ml (4hr) on storage than all the millet-cissus kunu samples. *Cissus populnea* flour granules have exhibited binding properties on millet starch granules in suspension, thereby slowing down the rate of sedimentation of starch granules in kunu beverage. In the last 4 hr of storage, millet-cissus kunu with 25% *cissus populnea* flour addition had sedimentation rates of 2 ml, 2 ml, 4 ml, 6 ml, 7 ml and 8 ml at 5.5 hr, 6 hr, 6.5 hr, 7 hr, 7.5 hr and 8 hr, respectively. Millet-cissus kunu with 10% cissus flour addition had the highest rate of sedimentation in the last 4 hr of storage, with 2, 4, 6, 12, 15, 18 and 19 ml of the starch granules had settled from the solution at 5, 5.5, 6.0, 6.5, 7, 7.5 and 8 hr, respectively. The 100% millet kunu (control) exhibited a slower rate of sedimentation with 1, 2, 4, 5, 6, 7, 7 and 8 ml of the starch granules settling out from the

solution at 4.5, 5, 5.5, 6, 6.5, 7, 7.5 and 8 hr of storage at ambient temperature.

### Discussion

Kunu like other beverages are higher in moisture content than any other parameter. This may be linked to the use of kunu principally for thirst quenching and refreshing purposes. Also, the climate of the zone where kunu is produced and consumed most predominantly calls for this. The dry season which coincide with the peak of production are particularly characterized by very hot weather and excessive loss of fluid. No significant difference was observed in the moisture content of millet-cissus kunu samples while millet kunu (control) had significantly ( $P \leq 0.05$ ) higher moisture content than all the millet-cissus kunu samples. The differences in moisture content (2.18-3.47%) may be due to the high water absorption capacity of *cissus populnea* mucilage flour. The moisture content of millet-cissus kunu samples conform to earlier findings by [24].

There was no significant statistical difference ( $P < 0.05$ ) between the protein content of millet-cissus kunu samples and control. All the kunu samples were generally low in protein content. The protein content of this study was in contrast with earlier findings of [24, 25]. The protein content of millet-cissus kunu has made it to be more nutritious than any of the carbonated soft drinks sold in Nigeria, that are devoid of protein but high in sugar, colouring and carbonated water content.

Fat content of millet-cissus kunu was found to increase with every 5% *cissus populnea* mucilage flour addition. The low fat content of both control and millet-cissus kunu samples were in conformity with the report of [24]. This could be attributed to the low fats (1-2%) content of cereals generally as earlier documented by [26]. The low fat content of millet-cissus kunu is an indication that *cissus populnea* mucilage flour is a poor source of fat.

There was great increase in the amount of fibre in each sample of millet-cissus kunu relative to control. This could be attributed to addition of the mucilage flour after filtration of millet kunu. This was in conformity with findings that cissus gum has very high water-absorption and swelling capacities, which makes them become both pseudoplastic and thixotropic in aqueous solution [8]. The high fibre content of millet-cissus kunu could be employed in the prevention/management/treatment of type 2 diabetes, hypercholesterolemia and body weight in humans.

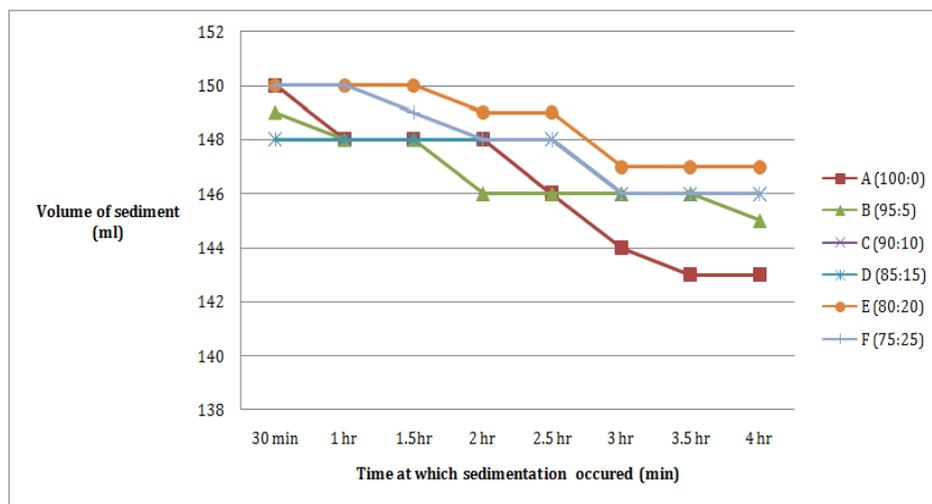
The high ash content of the millet-cissus kunu samples is an indication that the mucilage flour is a rich source of mineral elements. The processing technique employed has a direct effect on the ash content. Products whose processing method does not require filtration tend to be higher in ash content. On the other hand, among those filtered before consumption, variation in pore size of the sieving material is the determinant factor. Sieving materials with larger pore sizes have higher quantity of suspended particles hence higher ash content.

The carbohydrate contents were relatively low and may be attributed to filtration of millet kunu before addition of cissus

mucilage flour. The high fibre content of the kunu samples could account for their low carbohydrate content. The carbohydrate content of this study contrasted the findings of [27].

It was observed that the pH of millet-cissus kunu samples decreased with increase in *cissus populnea* flour addition relative to control and conforms with the earlier findings by that kunu is an acidic food [28]. The kunu samples were slightly acidic with pH (5.49 - 5.55) values for millet-cissus kunu and 6.43 for control. The low pH values (5.49 - 5.55)/acidity were due to slight fermentation during processing or addition of species of low acidic value for a sour taste. Adebayo et, al. had reported that the presence of lactobacillus, Acidophilus, Candida species and Saccharomyces cerevisiae bacteria which help in acid fermentation of kunu account for their acidity [25]. These bacteria however, have been reported to be non-pathogenic as they are beneficial to humans [25]. Products with low pH values have higher titratable acidity content and vice versa. Unfermented products tend to have higher values of pH tending towards the neutral state.

The values of titratable acid in all the millet-cissus mucilage flour substituted kunu samples were statistically similar ( $P < 0.05$ ) but lower than 3.30-3.40g/ml and 2.18-2.26g/ml reported by [28, 29, 26]. The titratable acid values of millet-cissus kunu were however, higher than 0.4608-0.3870 ml/min reported by [30]. The low value of TTA for millet-cissus kunu samples indicates poor fermentation with increased incorporation of cissus mucilage flour, which could have caused poor production of lactic acid. This invariably led to increase in their pH values.

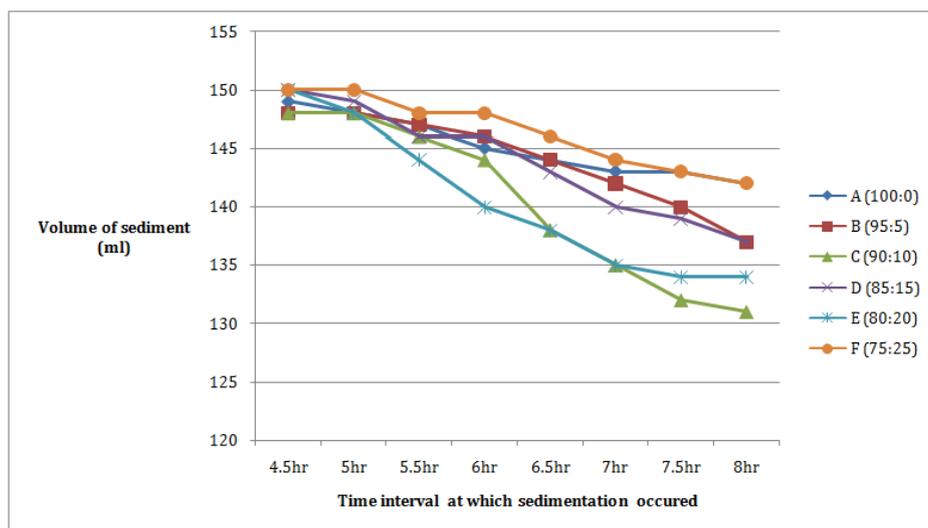


**Figure 1:** Sedimentation rates of millet-cissus kunu during 4 hr storage at ambient temperature

Key  
 A (100:0) = 100% millet kunu  
 B (95:5) = 95% millet kunu and 5% cissus flour  
 C (90:10) = 90% millet kunu and 10% cissus flour  
 D (85:15) = 85% millet kunu and 15% cissus flour  
 E (80:20) = 80% millet kunu and 20% cissus flour  
 F (75:25) = 75% millet kunu and 25% cissus flour

The values of the sedimentation rate (Figure 1 and 2) showed decrease in the sedimentation rates of millet-cissus kunu samples with increase in *Cissus populnea* mucilage flour incorporation. Abel et, al. had observed that, interactions between particles in a solution modify the settling behavior of a given particle, relative to that of an isolated particle. Abel and co-workers stated that the most significant interactions being hindered settling, clustering and diffusion [31]. In this study however, the predominant interaction observed was hindered settling, as addition of cissus mucilage flour may have decreased the sedimentation velocity of sorghum particles that were held in suspension in the

heterogenous solution. That is, as the volume fraction of cissus flour is increased, the average separation distance between each particle of sorghum is decreased. Hydrodynamic interactions are quite strong at these short separation distances, and thus may retard the motion of sorghum starch particles. Sedimentation rate is therefore decreased. This was in contrast with the earlier findings of [30]. Among the samples made with *Cissus populnea* mucilage flour, sample 95:5 had the highest sedimentation rate at the end of 8 hr of storage while the lowest rate was that of 80:20. This affirmed the hindered settling effect of cissus mucilage flour on sorghum starch particles in millet-cissus kunu beverage.



**Figure 2:** Sedimentation rates of millet-cissus kunu during 8 hr storage at ambient temperature

Key

A (100:0) = 100% millet kunu

B (95:5) = 95% millet kunu and 5% cissus flour

C (90:10) = 90% millet kunu and 10% cissus flour

D (85:15) = 85% millet kunu and 15% cissus flour

E (80:20) = 80% millet kunu and 20% cissus flour

F (75:25) = 75% millet kunu and 25% cissus flour

## Conclusion

The incorporation of *cissus populnea* mucilage flour in millet kunu production improved its proximate composition and functional properties but lowered the rate of sedimentation of this beverage. The production of *cissus populnea* mucilage flour should be exploited to enhance its utilization in the beverage industry.

## Acknowledgement

The authors most sincerely appreciate the staff of International Institute for Tropical Agriculture (IITA) Ibadan, Oyo State, Nigeria for assisting with the dehydration of the mucilage.

## Declaration

The authors declare that there is no conflict of interest.

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