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Physicochemical and Sensory Effects of *Cadaba Farinosa* Crude Extract on Cereal Starches During Kunun Zaki Production

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Abstract: Physicochemical and sensory effects of *Cadaba farinosa* crude extract on cereal starches during kunun zaki production were studied. The crude extract was able to hydrolyze gelatinized starch leading to its liquefaction. Generally, gelatinized starch produced more reducing sugars with the crude extract (0.023mg/ml) than native starch (0.008mg/ml) for millet. The same trend was observed in other crude extracts (malted rice, sweet potato and malted sorghum) and starches too. The crude extract of *C. farinosa* with increasing concentration decreased viscosity of kunun zaki and imparted varying effects on sensory qualities. Increasing concentration of the extract had more effect on flavour and above 0.25% (w/v) the acceptability decreased. Specific density of kunun zaki decreased (1.198-1.095) with increased concentration of *Cadaba farinosa*. Temperatures above 70 ^{0}C affected the hydrolyzing ability of the crude extract. Isolation and purification of the extract's components is desirable.

Key words: Cereal starch, kunun zaki, crude extracts

Introduction

Cereals are extensively used in Nigeria as source of food for humans. They are prepared in various forms. Okafor (1983) reported some of the cereal-based staples to include 'tuwo' (a stiff porridge eaten with vegetable soup and meat), 'ogi' (a weaning food) and 'kunun zaki' (a traditional, non- alcoholic, non-carbonated, sweetened thin free flowing gruel). During kunun zaki preparation, Gaffa and Jideani (2001) mentioned that some ingredients are introduced such as sweet potato paste, malted rice and malted sorghum. Among these agents is a less prominent member *Cadaba farinosa*. It is a West African plant known by different names as dangarafa (Hausa); legel (Fulani) in Nigeria; maure in Mauritania and Senegal; quinquemini in Guinea and balamji in Niger. In northern Nigeria, Burkill (1985) found the leaves and twigs of the shrub are edible after pounding and boiling into gruel. It could be pounded with cereals to produce a dry brown pudding or cake for consumption. The bark alone is eaten with cereals and its flowers macerated in water are added as a sweetener to scones of milled flour.

This shrub is cultivated by many in northern Nigeria and has a life span of not less than 20 years (Personal communication). The twigs are cut with leaves on them, sun dried, packed, and tied into small quantities for sale. From such bundles, the required quantity is broken, pounded using mortar and pestle and soaked in water prior to cold-water extraction. The resulting extract is filtered using a wire mesh and used in kunun zaki preparation. At present, information in the literature on the addition or use of this shrub crude extract during kunun zaki processing is scanty. Moreover, its exact role in the production of kunun zaki has not been scientifically proved. Gaffa and Jideani (2001) reported on sensory evaluation of different levels of the plant extract in kunun zaki. The present study is aimed at determining the exact role of the shrub's crude extract in kunun zaki processing and supplying the information lacking on this shrub. This would act as a useful basis for full exploitation of the shrub.

Materials and Methods

Materials: The dry stem of *Cadaba farinosa*, sweet potato chips, malted rice, sorghum, millet and maize grains were all bought in Bauchi-Nigeria.

Preparation of starch: Starch was prepared from sorghum, millet and maize grains separately being the cereals commonly used in kunun zaki preparation. The procedure of Takeda *et al.* (1988) was adopted in the preparation of pure starch from the cereals. The grains were washed separately, steeped in water (grain/water ratio, 1:2 v/v) for 12 hours to soften the kernels. Maize was steeped for 36 hours. They were washed again and ground to paste with a wet milling machine. The resulting paste was squeezed out through a muslin cloth, followed by filtration through several laboratory test sieves of varying pore sizes (100, 200 and 400μm) and the starch extracted repeatedly. This was washed with water several times by centrifugation at 8000g to obtain pure starch. Washing through centrifugation was continued until the pH of the supernatant became neutral and then air-dried and kept for further use.

Preparation of crude extract from *C. farinosa*, sweet potato tubers and malted rice: About 40 grams each of the three liquefying agents were separately pulverized in a mortar with pestle and transferred to a blender (Kenwood, 33 Bl 51, France) to which 200ml of distilled water were added and the mixture blended for 10 minutes. The contents were separately filtered using a 212μm pore size laboratory test sieve (Endecotts, No. BS 410, England). They were then centrifuged separately at 8000g each for 15 minutes and the supernatants decanted into other clean conical flasks, covered and kept in the refrigerator for further use.

Determination of the hydrolytic effect of *C. farinosa* crude extract: The hydrolytic effect of *Cadaba farinosa* and the other agents was investigated to establish their hydrolytic power on native and gelatinized starches. The extracts (0.1 ml) were added to 1ml native and gelatinized (1% w/v) sorghum, maize and millet starches separately in clean test tubes. This was incubated at 30°C for 30 minutes. The reducing sugar produced was estimated using the Somogyi (1952) colorimetric method from a standard graph.

Effect of *C. farinosa* extract on viscosity of kunun zaki: The effect of the extract on viscosity was determined by the falling ball gardiometric method (Kremer and Twigg, 1980). Varying concentrations of *Cadaba farinosa* crude extract (0.15, 0.20, 0.25 and 0.30% w/v) were added to 5% (w/v) gelatinized millet starch in test tubes and incubated at 30 °C for 30 minutes. Keeping the tubes in a boiling water bath for 5 minutes stopped the reaction.

Effect of *C. farinosa* crude extract on the specific density of kunun zaki: This was determined by the procedure of Giese (1995). Various concentrations of *C. farinosa* extract (0.2, 0.4, 0.8, and 1.6% w/v) were added to 1% (w/v) gelatinized millet starch and measured gravimetrically using a psychometric bottle and compared with equal volume of water at the same temperature.

Effect of heat on the hydrolytic power of *C. farinosa* extract: The crude extract (0.1 ml) was incubated with 1% (w/v) gelatinized starch from millet at various temperatures (40, 50, 60, 65, 70, 75 and 80 °C) using a thermostatically controlled water bath (Labovolt-Bain Marie No.83070, London), for 30 minutes. The amount of reducing sugar produced was used as a yardstick in estimating the hydrolytic effect. The Somogyi (1952) colorimetric method was used.

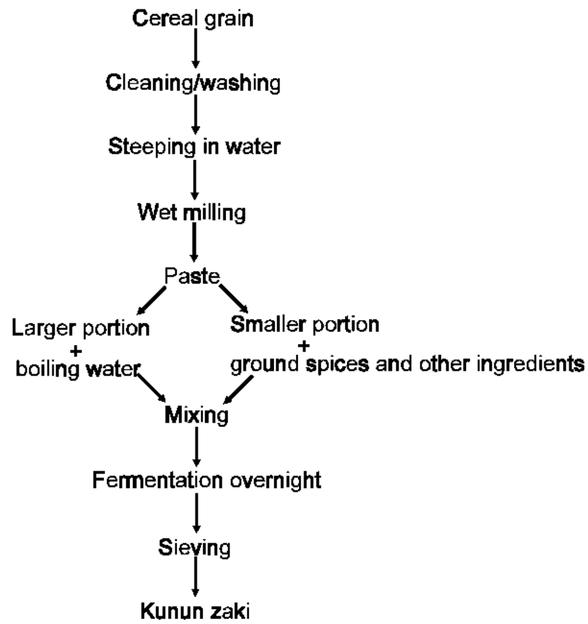

Fig. 1: Flow diagram of traditional kunun zaki production in Bauch-Nigeria

Sensory evaluation of kunun zaki with varying concentrations of *C. farinosa* crude extract: Crude extracts were obtained by pounding 20 g of *C. farinosa* stem in mortar with pestle to which 100 ml water was added and left at room temperature (29 °C) for 3 hours for effective extraction. Kunun zaki was prepared following the traditional production process (Fig. 1) common in the area. Varying percentages (0.15, 0.20, 0.25 and 0.30% w/v) of the crude extract were used separately as liquefying agent. The final products were presented for consumer acceptability evaluation using 25 untrained panelists who were familiar with the product. The nine point hedonic scale as reported by Ihekoronye and Ngoddy (1985) was employed in scoring the products. The qualities assessed include sweetness, colour, flavour, mouthfeel and overall acceptability.

Results

Hydrolytic effect of *C. farinosa*, malted rice, sweet potatoes and malted sorghum crude extracts on starches: The hydrolytic effect of the crude extracts of *C. farinosa*, sweet potatoes, malted rice and malted sorghum on native and gelatinized starches by the release of reducing sugars produced in each case based on the starch source utilized is presented in Table 1. Statistical analysis of the results indicated that there were significant differences ($p < 0.05$) in the amounts of reducing sugars produced in each category (native and gelatinized starch) and in each starch source utilized. There were no significant differences in amount of reducing sugars produced from the native millet

Table 1: Hydrolytic effect of crude extracts from *C. farinosa*, malted rice, sweet potato and malted sorghum on starches

	Amount of reducing sugars (mg/ml)					
	Millet		Sorghum		Maize	
Extracts	N	G	N	G	N	G
C. farinosa	0.008	0.0230	0.008	0.019	-	0.0095
Malted rice	0.009	0.0265	0.008	0.024	0.0068	0.0253
Sweet potato	0.010	0.0270	0.010	0.026	0.0090	0.0240
Malted sorghum	0.007	0.0230	0.008	0.028	0.0080	0.0210
LSD (p< 0.05)	0.00059	0.00057	0.0006	0.00051	0.0021	0.0007

N- native starch; G - gelatinized starch.

Table 2. Effect of *C. farinosa* crude extract on viscosity and sensory qualities of kunun zaki

Concentration (% w/v)	Viscosity (Nsm^{-2})	Colour	Sweetness	Flavour	Mouthfeel	Acceptability
0.15	$3.21x10^{-2}$	7.63	6.04	6.81	6.26	6.85
0.20	$2.84x10_{-2}$	7.56	6.26	6.56	6.00	6.67
0.25	$2.31x10^{-2}$	7.74	7.04	7.11	6.70	6.89
0.30	$1.56x10^{-2}$	7.67	6.48	6.07	5.52	6.07
LSD (p<0.05)	-	NS	NS	0.691	NS	NS

NS – Not Significant at 5%.

starch by extracts from *C. farinosa* and malted sorghum. The amount of reducing sugar in the native and gelatinized starch categories of each starch source showed that there were significant differences between them in each of the millet, sorghum and maize starches.

Effect of *C. farinosa* extract on specific density of kunun zaki: The specific density of kunun zaki decreased with increasing concentration of crude extract as presented in Table 2. The values ranged from 1.198 for the control (0%) to 1.095 for the sample to which 1.6% extract was added.

Effect of heat on the hydrolytic power of *C. farinosa* crude extract: Increase in temperature was noted to have corresponding increase in reducing sugar produced by the extract at 0.25% (w/v) concentration. The amount of reducing sugar produced at the corresponding temperature is presented in Fig. 2. The highest amount of reducing sugar produced was 0.029-0.031 mg/ml corresponding to the temperature range of 60-70 ^{o}C. Above this temperature, reducing sugar value produces dropped to 0.021 mg/ml and still lower at 80 ^{o}C.

The effect of *C. farinosa* on viscosity and sensory evaluation of kunun zaki: The results of the viscosity measurements and the mean scores for the sensory evaluation are presented in Table 3. Increase in concentration of *C. farinosa* crude extract on gelatinized starch caused a decrease in viscosity. The crude extract at 0.25% (w/v) produced the best kunun zaki with the highest mean scores in colour, sweetness, flavour, mouthfeel and overall acceptability. Though the mean scores for colour remained fairly constant at all the concentrations (0.15-0.30%) the mean scores for sweetness, flavour and mouthfell decreased. The flavour imparted at higher concentration above 0.25% seem objectionable to many. Statistical analysis however showed that there were no significant differences ($p < 0.05$) in the mean scores for the various parameters except flavour.

Discussion

The ability of the various crude extracts to hydrolyze starch (Table 1) and produce reducing sugars suggests that they all possess starch-hydrolyzing enzymes. This result agrees with Karel (1975) who reported the occurrence of amylases in soybeans and sweet potatoes. The presence of amylases has also been confirmed in malted rice and sorghum (Meyer, 1987). Differences in the amounts of reducing sugar produced by the extracts from each of the sources is due to inherent differences in the types and amount of each enzyme they possess. The low amount of reducing sugar produced by each of the extracts from the native starch compared with the gelatinized starches shows that the enzymes preferred gelatinized starches. The rate and extent of starch hydrolysis depend on the state and the starch granule particularly the type of physical treatment the starch has received. The native starch granules possibly possess a barrier to enzymic attack, which with the onset of gelatinization the heat has caused to be destroyed. This might have paved way for the starch granules becoming susceptible to enzyme action. This view agrees with Wursch (1990) who

Table 3: Effect of *C. farinosa* on specific density of kunun zaki

Concentration (%w/v)	Specific density
0	1.198 ± 0.14
0.2	1.176 ± 0.08
0.4	1.135 ± 0.04
0.8	1.109 ± 0.06
1.6	1.095 ± 0.10

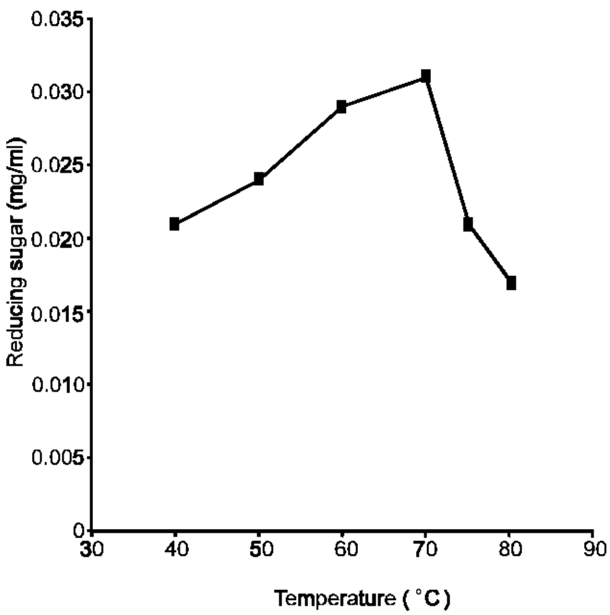

Fig. 2: Effect of heat on hydrolytic power of *C. Farinosa* crude extract at 0.25% (w/v) concentration

observed that native starch seemed resistant to enzyme attack.

Effect of *C. farinosa* on viscosity and sensory qualities of kunun zaki: The decrease in viscosity of kunun zaki with increasing concentration of *C. farinosa* extract (Table 2) means that there was a breakdown of larger molecular weight components into smaller ones making the slurry to become watery. This is the liquefaction process common with alpha amylases that catalyzes the hydrolysis of starch into low molecular weight dextrins (Yamamoto, 1988). The higher concentrations (0.8-0.16%) of *C. farinosa* extract caused a decrease in the molecular weight of the molecules with subsequent liquefaction of starch. This is indicative of amount of enzyme acting on the substrate and agrees with Meyer (1987).

The increase in mean scores for colour of kunun zaki produced with increasing concentrations of *C. farinosa* showed that the extract had no effect on the colour of the beverage. It would appear that the light yellow colour of the extract was masked by the dominant gray colour of the grains used. The final colour of kunun zaki is usually that of the main raw material used. The reason for the decrease in mean sensory scores for sweetness (Table 3) of kunun zaki containing 0.30% *C. farinosa* is not clear. It is however possible that the pungent flavour imparted by higher concentration of *C. farinosa* extracts influenced the scores. This pungent flavour may have affected the mouthfeel and overall acceptability of the beverage. Flavour is a strong determinant factor of the beverage acceptability compared with other qualities. The use of *C. farinosa* as a starch-hydrolyzing agent improved the sweetness of the beverage due probably to the release of sugars by the hydrolyzing enzymes. Burkill (1985) observed that the leaves of *C. farinosa* are cooked with cereals to make the product sweet.

Effect of *C. farinosa* on specific density: The same principle in the effect of *C. farinosa* on viscosity is also true of the extract's effect on specific density (Table 3). The decrease in specific density of kunun zaki with increasing concentration could be due to the breakdown of the gelatinized starch by the hydrolyzing enzymes present in the crude extract. The alpha amylases as reported by Brigg *et al.* (1994) are implicated in this and the bonds hydrolyzed are the 1-4 linkage of starch. Such reactions reduce the viscosity of starch containing mixture.

Effect of heat on the hydrolytic power of *C. farinosa* crude extract: The increase in temperature that caused a corresponding increase in amount of available reducing sugar (Fig. 2) agrees with Chaplain and Bucke (1992) mode of action of enzymes, which increase their activity with increase in temperature. The highest amount of reducing sugar recorded (0.029-0.031mg) falls within the temperature range of 60-70 ^{0}C corresponding to the optimum temperature for amylases (Shinke, 1988). The drop in reducing sugar level from 0.031mg/ml at 70 ^{0}C to 0.021mg/ml at 75 ^{0}C means that the enzyme molecule is disfigured by heat leading to molecular rearrangement that causes a loss of the active centers for the enzyme resulting in loss of efficiency. Cheetam (1987) noted a similar effect.

Conclusion: *Cadaba farinosa* possess some starch hydrolyzing properties, as it is capable of causing starch liquefaction, reducing viscosity and decreasing specific density. However this ability is dependent on the physical state of the starch molecule. Gelatinized starch is more susceptible to the attack than native starch. Temperatures above 70^{0}C affect the hydrolyzing ability of enzymes from *C. farinosa*. A concentration of the crude extract from the plant at 0.25% (w/v) produced kunun zaki with the best sensory qualities. A purification of enzymes from this source may be desirable.

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