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Evaluation of the Effect of Thermal Radiation on the Physicochemical Propertiesof Improved Cassava Cultivars (*Esculenta Crantz*) and Roasted Gari in South-South Nigeria.

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ABSTRACT: *Three improved variety of cassava cultivars grown within 2 km flare distance in Rumuekpe flow station of Rivers State were studied for the effect of thermal radiation on the physiochemical properties and sensory parameters. The cassavas for the studies were coded NR-8082, NR-84292, and TMS-30572. The plots were designed according to distances: 0-150m, 150-300m, 300-450m, 450-600m and 1000-2000m. Randomised complete block design (RCBD) with three (3) treatments in five replications was used. The results showed that at 0-150m, 450-600m and 1000-2000m,the thermal radiation was (603.84w/m^2),(448.91±5.37d w/m^2,) and (428.83±0.79ew/m^2) respectively. At radiation level of 603.84±5.76a, the moisture content of raw cassava ranged from 56.5-57.4% for all the cultivars, while protein values (1.18-1.31%), Total carbohydrate (35.0 - 36.6%) for all cultivars. At the control radiation level 428.83±0.79e, moisture values (64.2-71.4%), protein (2.00-2.30%), Total carbohydrate (17.8- 27.6 %) for all cultivars. The proximate composition showed that moisture content of gari: TMS-30572 (9.5%), (NR-8082 (9.0%), NR-84292 (9.8%), Protein values, TMS-30572 (1.15%), NR-8082 (1.10%), and NR-84292 (1.20%). The fat content of gari ranged from (0.5 to 0.60) for NR-84292, NR-8082 and TMS-30572.Ash content, NR-84292 (1.70%), TMS-30572 (1.90%), and NR-8082 (2.0%). Total carbohydrate, NR-84292 (85.25%), NR-8082 (85.20%), TMS-30572 (85.00%) with Thermal radiation (603.84±5.76a), whilst at radiation level (428.83±0.79e), Moisture content of gari : TMS-30572 (9.9%), NR-8082 (9.8%), NR-84292 (9.8%), Protein values The effect of thermal stress was significant on the proximate composition (P<0.001) at 0-150m flare distance for both raw and roasted gari. The percentage starch content for three cultivars are NR-8082 (37.34%), NR-84292 (40.7%), and TMS-30572 (39.09%), with cultivar's NR-84292 (40.7%) having the highest starch value. The residual cyanide level of roasted gari was determined (Mg HCN equivalent Kg^{-1}), NR-84292 (13.24), NR-84292 (28.16), and TMS-30572 (24.18). The highest level of reduction was NR-84292 (82.58%), least was TMS-30572 (79.46%) and NR-8082 (80.98%). $_P$H decreases from 6.94 to 4.08 and 3.8 in 72 hours for pulp and gari for TMS-30572. $_P$H for NR-84292 (6.66 to 4.05 and 3.8), NR-8082, pH decreases from (6.92 to 4.10 and 3.80) for pulp and gari at 72 hours fermentation process that shows significant effect. The pH of fermenting cassava pulp and roasted gari decreases, while the titratable acidity increases as the fermentation progressed. The value of the relative bulk density, swelling index and water absorption capacity increases as the distance from the flare increases. Sensory evaluation of gari from TMS-30572 and NR-8082 with high yield were preferred in overall general acceptability to NR-84292.Correlation analysis of the proximate composition, physiochemical properties and sensory evaluation of gari showed significant relationship at 300-2000M flare distance. It was evident in the overall study that the effect of thermal radiation on cassava performance shows significant effect.*

Keywords: *Cassava cultivars, thermal Radiation, Physicochemical, Flare, gari,*

I. INTRODUCTION

Over the years priority has been placed on the economic exploits of the oil boom, with less emphasis on the impacts of these activities on the food chain. As a result of these drawbacks, research has introduced the use of improved and exotic cultivars which have the advantage of high resistance to disease and pest, heat, short maturation time, rapid response to fertilizers, low cyanide content and low bulky properties.In spite of these advantages of the improved cultivars, rural farmers are still known to complain over drastic reduction in yield, poor starch properties and other known physicochemical and sensory properties. In South- South Region of Nigeria, most gas flaring rural communities engage in cassava production for survival.The Niger Delta mangrove and rainforest belt in the South –South Region is one of the most fragile ecosystems in the world. It is the most oil- impacted environment and polluted area in the world[1]

Cassava (*ManihotesculentaCrantz*) a starchy food crop, serves as a major source of calories for more than 500 million people in the third world countries[2] . The cassava plant also produces a good crop of leaves, which are vegetables, or as an accompaniment to the main staple and it is a rich source of minerals, and vitamins[3]. However, when cassava is processed, it is an important food for many people and most popularly used in the production of gari, a staple food in Nigeria[3]. On a global scale, cassava (*Manihot esculenta*) represents both an important human food resource and, in many regions, an underutilized animal feed ingredient. Cultivated in tropical/subtropical environment[1]. In recent years, the African continent produced ~60% of the global cassava crop (256 million tons) through targeted efforts to develop improved varieties.[1]

Specific nutrient imbalances and toxins have been identified in cassava that can limit its feed/food value. Thepresence of cyanogenic compounds in various cultivars and plant fractions has notably received disproportionateresearch attention compared with other chemical constituents. Nonetheless, traditional and basic processingmethods for minimizing cyanide toxicity including soaking, drying, and fermentation, have been documentedeffective across species, and can be applied with more advanced technologies for industrial commercializationof safe cassava feed/food ingredients. According to Lukuye et.at ,[1]Improved feeding value resulting from targeted fungal and microbialfermentation have been demonstrated with the capacity to expand cassava root (and by-product) utilizationfor both applied livestock and human nutrition by minimizing cyanogenic compounds, degrading complexcarbohydrates, and improving protein content.

In the past, most cassava products were obtained from old cultivars and had advantages of relatively high yield of starchy roots on marginal lands, thrived well in exhausted soil, tolerant to draught, pest and diseases. Despite these advantages, the draw backs of these old cultivars however include high bulky properties of its starch, long maturation time, and high content of cyanogenic glucosides which necessitates efficient processing to remove the potential toxins [4]. Cassava plants are cultivated commonly in almost all types of soils including those surrounding the flow station.

Rumuekpe gathering station is one of the facilities owned by a multinational oil company in Port Harcourt, South-South region of Nigeria. Thus, the company has been concerned about gas flaring since the inception of its oil production.For the purpose of this study, the main Thermal radiation is gas flare. Thus, gas flaring as one of the processes of resource exploitation could be defined as a controlled disposal of surplus combustible vapours by igniting them in the atmosphere[5].

A large proportion of gas flared for instance in the South- South of Nigeria is vented as methane, which goes to show how many tons of this substance is released into the atmosphere per year. Increased temperature in gas flared areas ranges from 1300-1400^{o}C[6]. This is considered very high for both plant and animal life, because they contain sulphides, carbonates and nitrates, resulting as hydrogen sulphides, (H_2S), sulphur-dioxide (SO_2), carbon monoxide (CO), nitrogen dioxide (NO_2), etc. which may be involved due to the atmosphere of the flaring environment and are carried away many kilometers depending on wind speed and direction. This causes some physiological changes in certain vegetation most likely leading to death. Some of the effects most probably on plants are internodes shortening of apical internodes, leaf distortion, and discoloration, crinkling, and pebbling, reduction in leaf size as well as in chlorophyll contents due to oxygen deficiency and gas toxicity in the environment [6].

Miller [7], reported that thermal radiation over the years are known to cause growth reduction, defined as reduction in the growth of the organism as well as reduced seed germination, abnormalities, or reduction in viability of offspring’s. Also, according to Ryan [8], thermal radiation resulted in direct burn damage to exposed tissue. Similarly, most oil companies and Government agency with their various agricultural units will find this research information useful for onward dissemination to the rural farmers in their areas of operations via their Extension Services Unit. This study considered flare as the main thermal radiation and assessed its effect on the physicochemical properties of freshly peeled cassava and roastedgari from3 (three)improved cassava cultivars.

II. MATERIALS AND METHODS

The experimental plots were sited on an agro-ecological zone. The coastal plain sands – Rumuekpe flowlocated in Emuoha Local Government Area of Rivers State, which is on a mid-point coordinate of Latitude 4^o 58' 49"N and Longitude 6^o 41' 15" E via mid-belt of 469571 EE, and 108624 MN.[9].

Rumuekpe is a humid tropical area. The rainfall pattern is bimodal with peaks in June and September, and the period of low precipitation in August. The long rainy season is between April and early August, while the short rainy season is between late August and October. The dry season is from November to March interrupted occasionally by sporadic down pour. Rumuekpe, like Port Harcourt within latitude 04^0 5^1 and longitude 07^0 01^1 E[10] has an annual rainfall of between 2000mm and 2453mm, while the annual temperature is between 22.6^{0}C and 31.2^{0}C [11]. The experiment was conducted for a period of 12 months:

Three exotic cultivars used for the experiment were obtained from the National Root Crop Research Institute (NRCRI) Umudike, Abia state and International Institute of Tropical Agriculture (IITA), Onne sub-station.

These were: TMS – 30572; NR – 8082 ; NR – 84292

Experimental design

A randomized complete block design (RCBD) with three (3) treatments in five replications was used. The plots were designed according to distance: 0-150m, 150-300m, 300-450m, 450-600m and 1000-2000m. All the experimental plots were in the downward direction. Control plot was located at a distance of 2000m (Elele Road) near well 4 approximately 2km – North West of the flare downwind direction, as contained in Table 1.

Table 1.0: Layout of the experimental plots- Landpreparation and planting

0 – 150m	150 – 300m	300 – 450m	450 – 600m	1000 – 2000m
NR – 8082	NR – 8082	NR – 8082	NR – 8082	NR – 8082
TMS– 30572	TMS – 30572	TMS – 30572	TMS – 30572	TMS–30572
NR – 84292	NR – 84292	NR – 84292	NR – 84292	NR – 84292

Thermal radiation:

Heat radiation was measured with a pyranometer (Serial No: SOL 5256 100224922) equipped with an automatic logging system. The sensor was focused towards the direction of flare for Ten minutes interval to record radiation every ten seconds interval. The mean reading taken over the ten minutes for a period of 1hr (one hour) exposure time was then recorded as the thermal radiation value at 0-150 m and this was done for the 2 km farm layout.

Garification process:

The garification of the tubers was assessed by the method of Kemdirm *et al*., [12]. The cassava tubers were harvested from the farm after age of 12 months.

The sample each weighing 10kg was taken from each plots (0-150m, 150-300m, 300-450m, 450-600m, 1000-2000m flare distance). Samples were washed to get rid of debris and peeled immediately. The weight of the rinds (peels) and the parenchyma of the tubers were separately determined with aweighing balance. The parenchyma was washed and grated with electric-motor-driven grating machine. Each sample was separately grated and the mash was collected into a sack made of polypropylene material. The sacks were coded and then tied appropriately with sticks to allow dewatering and fermentation.

The grater was washed with large quantity of water before the introduction of the next sample into the grater. During the process of dewatering and fermentation, samples were collected for the determination of some physicochemical parameters at zero hour, 24hours, 48hrs and 72 hours. At the end of the fermentation the mash lumps were crumbled with hand and the fibrous portion sifted with iron sieve of mash size (2.00mm). The respective weights of the sifted portions and the trash (fibrous) portion were determined. The garification (roasting) was done with a wide iron fryer (pan), using O-Gas burner as the source of energy. Roasting was discontinued when the product dried to moisture content of 8 – 10 percent[13]. The gari was spread out on a tray at room temperature (28 – 30 ^{0}C) before packaging.

Chemical analysis (Proximate composition)

Proximate composition of various samples of raw cassava and roasted gari such as Moisture, Ash, crude fibre, Fat/oil (Ether extract), Crude Protein, Total Titratable acidity, were analysed using the methods of the Association of Official Analytical Chemists [14]

pH détermination

The pH of the fermenting cassava pulp from zero day to three days and that of the freshly fried gari were determined with the aid of apH meter(Unicam 9450 Model)

Determination of hydrogen cyanide (HCN)

Hydrogen cyanide concentration of the freshly grated cassava (pulp) and the residual cyanide of the freshly roasted gari were determined following the modified methods of Ikediobi *et.al*,[15].

Starch content determination by sedimentation method

30 g of freshly peeled root were blended (with natural blender) for 5minutes. The blended sample was sieved with laboratory sieve (mesh size 300µm) and rinsed severally with tap water to wash out starch. The filtrate was allowed to stand for one hour to sediment. The separated water was drained off and the starch scooped into a crucible. The sample in the crucible was dried at 80^0C to a constant weight [14]

Determination of total available carbohydrate (TAC)

Total available carbohydrate was estimated by the method described byOsborne and Voogt[16].

Physical analysis:

Relative bulk density was determined using the method of Akpapunam and Markakis [17]as modified[13]. Water absorption capacity was determined using the method of Beuchart [18] as modified[13].Swelling index of gari was determined by the method employed by Ukpabi and Ndimele [19], and Achinewhu et.at[13]

Data Analysis:

The statistical differences were analysed by analysis of variance and least significant difference as described by Wahua,[20]Using mean of three determinations.

Also, descriptive analysis and two-way analysis of variance (ANOVA) were performed to determine the general trend of experimental data. Mean separation was performed on the analysed data using Duncan' smultiple test with the aid of SAS version 9.1 software (SAS 2003)[21]

III. RESULTS AND DISCUSSION

Table 2.0. shows the effect of thermal radiation and cultivar on the proximate composition of freshly peeled cassava tubers.
Table 3.0. shows the effect of thermal radiation and cultivars on the proximate composition of roasted gari.
Table.4.0. showsthe effect of thermal radiation and cultivars on physical properties of roasted gari.
Table 5.0. shows the effect of thermal radiation on the Starch content and Hydrogen cyanide of freshly harvested cassava tubers and roasted gari (mg HCN equiv. Kg^{-1})
Table 6.0. shows the effect of thermal radiation on the pH and %Total Titratable Acidity of cassava pulp and roasted gari
Table 7.0.shows the effect of thermal radiation and cultivars on the sensory evaluation of roasted gari
Fig.2.0. shows theeffect of flare distance and cassava cultivar on water absorption capacity (g/g) of roasted gari
Fig. 3.0. shows theeffect of flare distance and cultivar on relative bulk density (g/cm³) of roasted gari
Fig. 4.0. shows the effect of flare distance and cassava cultivar on the swelling index (ml) of roasted gari

Table 2.0 showed the effect of thermal radiation and cultivars on the proximate composition of freshly peeled cassava tubers. The average moisture content of freshly peeled cassava from three cultivars at various flaring distances were as follows: NR-8082 (56.5%), NR-84292 (59.2% and TMS-30572 (57.4%) at 0-150m (603.84±5.76a w/m2), while the highest moisture content of 73.6% was recorded for TMS-30572 at 450-600m (448.91±5.37d w/m2). At the control point 1000-2000m (428.83±0.79e w/m2), NR-8082 (64.2%), NR-84292 (67.5%) and TMS-30572 (71.4%) respectively agreed with recommended values. The moisture content of peeled cassava at 0-150m, with a thermal radiation of (603.84±5.76a w/m2**)** had low moisture content below the recommended values as reported by Achinewhu and Owuamanam [23]**.**

Cassava consists of 60-70% water, processing it into a dry form reduces the moisture content and converts it into a more durable and stable product with less volume which makes it more transportable, [24,25]. The moisture content increased as the distance from the flare increases and thermal radiation decreases. The lower moisture content of cassava grown at 0-150m (603.84±5.76a w/m2), showed the state of drought tolerance exhibited by crops grown at this distance and radiation level. TMS-30572 has the highest protein content of 2.40% at 450-600m **(**448.91±5.37d w/m2**),** and NR-8082 (1.18%) had the least protein value at 0-150m. At the control point, NR-8082 had protein value of (2.00%) NR-84292 (2.10%) and TMS-30572 (2.30%). Cultivars closed to the flare point (0-150m) (603.84±5.76a w/m2) had the least protein value, which could be due to thermal effect. Fat content ranged from 0.5 - 0.9% at 0-2000m. The influence of flare distance and cultivars shows no effect on fat content. These findings agreed with the work of Achinewhu and Owuamanam, [23]. The crude fibre ranges from 1.60-2.20% for TMS-30572 and NR-84292 at 450-600m and 150-300m, the control value at 1000-2000m, NR-8082 had crude fibre (2.0%), NR- 84292 (1.80%) and TMS-30572 (1.91%).

Table 2.0: Effect of thermal radiation and cultivar on the proximate composition of freshly peeled cassava tubers

Flare distance (m)	Cultivars	Thermal Radiation (w/m2) Mean ± SEM	Moisture content Mean ± SEM	Protein Mean ± SEM	Fat Mean ± SEM	Ash Mean ± SEM	Crude fibre Mean ± SEM	Total carbohydrate Mean ± SEM
0-150	NR - 8082	603.84±5.76a	56.5 ± 0.1^{n}	1.18 ± 0.02^{i}	0.8 ± 0.1^{a}	2.4 ± 0.1^{a}	2.00 ± 0.06^{ab}	36.6 ± 0.1^{ab}
	NR - 84292	603.84±5.76a	59.2 ± 0.1^{k}	1.31 ± 0.01^{h}	0.7 ± 0.1^{a}	2.0 ± 0.1^{abcd}	1.70 ± 0.06^{cd}	35.0 ± 0.1^{abcd}
	TMS 30572	603.84±5.76a	57.4 ± 0.1^{m}	1.31 ± 0.01^{h}	0.6 ± 0.1^{a}	2.2 c± 0.1^{ab}	1.90 ± 0.06^{bc}	35.8 ± 0.1^{abc}
150-300	NR – 8082	588.40±4.0b	58.2 ± 0.1^{l}	1.57 ± 0.03^{j}	0.7 ± 0.1^{a}	2.2 ± 0.1^{ab}	1.80 ± 0.06^{bcd}	34.9 ± 0.1^{abcd}
	NR - 84292	588.40±4.0b	61.3± 0.1^{j}	1.80 ± 0.01^{e}	0.8 ± 0.1^{a}	2.1 ± 0.1^{abc}	2.20 ± 0.06^{a}	31.0 ± 0.1^{abcde}
	TMS 30572	588.40±4.0b	61.7 ± 0.1^{i}	1.70 ± 0.01^{f}	0.6 ± 0.3^{a}	2.0 ± 0.1^{abcd}	1.90 ± 0.06^{bc}	31.4 ± 0.1^{abcde}
300-450	NR - 8082	557.29±1.49c	64.2 ± 0.1^{h}	2.00 ± 0.01^{d}	0.5 ± 0.1^{a}	1.6 ± 0.0^{d}	2.01 ± 0.01^{ab}	39.1 ± 0.1^{a}
	NR - 84292	557.29±1.49c	65.1 ± 0.1^{g}	2.10 ± 0.01^{c}	0.5 ± 0.1^{a}	2.2 ± 0.1^{ab}	1.75 ± 0.01^{cd}	28.3 ± 0.1^{abcdef}
	TMS –30572	557.29±1.49c	70.4 ± 0.1^{c}	2.40 ± 0.01^{a}	0.8 ± 0.1^{a}	1.8 ± 0.0^{bcd}	1.70 ± 0.01^{cd}	22.4 ± 0.1^{def}
450-600	NR - 8082	448.91±5.37d	66.3 ± 0.1^{f}	2.00 ± 0.01^{d}	0.8 ± 0.1^{a}	1.7 ± 0.1^{cd}	1.80 ± 0.01^{bcd}	27.0 ± 0.1^{abcdef}
	NR - 84292	448.91±5.37d	68.2 ± 0.1^{d}	2.10 ± 0.01^{c}	0.6 ± 0.1^{a}	2.3 ± 0.0^{a}	180 ± 0.01^{bcd}	23.1 ± 1.8^{cdef}
	TMS –30572	448.91±5.37d	73.6 ± 0.1^{a}	2.40 ± 0.01^{a}	0.7 ± 0.1^{a}	1.6 ± 0.3^{d}	1.60 ± 0.01^{d}	22.1 ± 2.5^{ef}
1000-2000	NR - 8082	428.83±0.79e	64.2 ± 0.1^{h}	2.00 ± 0.01^{d}	0.9 ± 0.01^{a}	1.8 ± 0.0^{bcd}	2.00 ± 0.06^{ab}	27.6 ± 1.5^{abcdef}
	NR - 84292	428.83±0.79e	67.5 ± 0.1^{e}	2.10 ± 0.01^{c}	0.5 ± 0.01^{a}	2.3 ± 0.1^{a}	1.80 ± 0.01^{bcd}	25.3 ± 0.1^{bcdef}
	TMS –30572	428.83±0.79e	71.4 ± 0.1^{b}	2.30 ± 0.01^{b}	0.7 ± 0.01^{a}	1.9 ± 0.0^{abcd}	1.91 ± 0.01^{bc}	17.8 ± 7.8^{f}

Within column, Mean ± SEM with different superscripts are significantly different at the P<0.05

Table 3.0: Effect of thermal radiation and cultivars on the proximate composition of gari from cassava tubers

Flare distance (m)	Cultivars	Thermal Radiation (w/m2) Mean ± SEM	Moisture content Mean ± SEM	Protein Mean ± SEM	Fat Mean ± SEM	Ash Mean ± SEM	Crude fibre Mean ± SEM	Total carbohydrate Mean ± SEM
0-150	NR - 8082	603.84±5.76a	9.0 ± 0.01^{e}	1.10 ± 0.01^{h}	0.6 ± 0.01^{ab}	2.00 ± 0.01^{a}	2.00 ± 0.01^{a}	85.20 ± 0.01^{c}
	NR - 84292	603.84±5.76a	9.7 ± 0.01^{cd}	1.20 ± 0.01^{f}	0.5 ± 0.01^{ab}	1.70 ± 0.01^{d}	1.66 ± 0.01^{f}	85.25 ± 0.01^{b}
	TMS –30572	603.84±5.76a	9.5 ± 0.01^{d}	1.15 ± 0.01^{g}	0.5 ± 0.01^{ab}	1.90 ± 0.01^{b}	1.89 ± 0.01^{b}	85.00 ± 0.01^{e}
150-300	NR – 8082	588.40±4.0b	9.6 ± 0.01^{cd}	1.10 ± 0.01^{h}	0.6 ± 0.01^{ab}	2.00 ± 0.01^{a}	1.60 ± 0.01^{f}	85.10 ± 0.01^{d}
	NR - 84292	588.40±4.0b	9.8 ± 0.01^{bcd}	1.40 ± 0.01^{e}	0.6 ± 0.01^{ab}	1.90 ± 0.01^{b}	2.00 ± 0.01^{a}	84.30 ± 0.01^{l}
	TMS 30572	588.40±4.0b	9.9 ± 0.01^{bc}	1.40 ± 0.01^{e}	0.6 ± 0.01^{ab}	1.80 ± 0.01^{c}	1.80 ± 0.01^{c}	84.40 ± 0.01^{j}
300-450	NR - 8082	557.29±1.49c	9.8 ± 0.01^{bcd}	1.16 ± 0.01^{d}	0.5 ± 0.01^{ab}	1.35 ± 0.01^{h}	1.80 ± 0.01^{c}	84.95 ± 0.01^{f}
	NR - 84292	557.29±1.49c	9.8 ± 0.01^{bcd}	2.00 ± 0.01^{a}	0.4 ± 0.01^{ab}	2.00 ± 0.01^{a}	1.65 ± 0.01^{e}	84.15 ± 0.01^{n}
	TMS 30572	557.29±1.49c	10.1 ± 0.01^{ab}	2.00 ± 0.01^{a}	0.6 ± 0.01^{ab}	1.47 ± 0.01^{g}	1.60 ± 0.01^{f}	84.23 ± 0.01^{m}
450-600	NR - 8082	448.91±5.37d	9.7 ± 0.01^{cd}	1.40 ± 0.01^{e}	0.6 ± 0.01^{a}	1.50 ± 0.01^{g}	1.40 ± 0.01^{h}	84.40 ± 0.01^{a}
	NR - 84292	448.91±5.37d	9.8 ± 0.01^{bcd}	1.60 ± 0.01^{d}	0.5 ± 0.01^{ab}	2.00 ± 0.01^{a}	1.75 ± 0.01^{d}	84.35 ± 0.01^{k}
	TMS 30572	448.91±5.37d	10.3 ± 0.01^{a}	2.00 ± 0.01^{a}	0.7 ± 0.01^{a}	1.60 ± 0.01^{f}	1.50 ± 0.01^{g}	84.00 ± 0.01^{o}
1000-2000	NR - 8082	428.83±0.79e	9.8 ± 0.01^{bcd}	1.80 ± 0.01^{c}	0.8 ± 0.01^{a}	1.50 ± 0.01^{g}	1.20 ± 0.01^{i}	84.70 ± 0.01^{h}
	NR - 84292	428.83±0.79e	9.8 ± 0.01^{bcd}	2.00 ± 0.01^{a}	0.6 ± 0.01^{ab}	1.70 ± 0.01^{d}	1.10 ± 0.01^{k}	84.80 ± 0.01^{g}
	TMS 30572	428.83±0.79e	9.9 ± 0.01^{bc}	1.90 ± 0.01^{b}	0.8 ± 0.01^{a}	1.65 ± 0.01^{e}	1.15 ± 0.01^{j}	84.46 ± 0.01^{i}

Within column, Mean ± SEM with different superscripts are significantly at the P<0.05. **Mean of 3 determinations**

Table 4. 0. Effect of thermal radiation and cultivars on physical properties of roasted gari

Flare distance (m)	Cultivars	Thermal Radiation (w/m2) Mean ± SEM	Relative bulk density (g/cm^3) Mean ± SEM	Water absorption capacity (g/g) Mean ± SEM	Swelling index (ml)Mean ± SEM
0-150	NR - 8082	603.84±5.76a	0.410 ± 0.001^{m}	6.2 ± 0.1^{a}	280 ± 1.0^{i}
	NR - 84292	603.84±5.76a	0.310 ± 0.001^{n}	5.1 ± 0.1^{b}	250 ± 1.0^{j}
	TMS – 30572	603.84±5.76a	0.550 ± 0.001^{h}	4.0 ± 2.0^{c}	290 ± 1.0^{h}
150-300	NR – 8082	588.40±4.0b	0.451 ± 0.001^{l}	6.8 ± 0.1^{a}	290 ± 1.0^{h}
	NR - 84292	588.40±4.0b	0.450 ± 0.001^{l}	7.1 ± 0.1^{a}	280 ± 1.0^{i}
	TMS – 30572	588.40±4.0b	0.590 ± 0.001^{g}	7.2 ± 0.2^{a}	300 ± 1.0^{g}
300-450	NR - 8082	557.29±1.49c	0.490 ± 0.001^{k}	7.4 ± 0.1^{a}	300 ± 1.0^{g}
	NR - 84292	557.29±1.49c	0.700 ± 0.001^{c}	7.9 ± 0.1^{a}	320 ± 1.0^{e}
	TMS – 30572	557.29±1.49c	0.605 ± 0.001^{f}	7.6 ± 0.1^{a}	310 ± 1.0^{f}
450-600	NR - 8082	448.91±5.37d	0.500 ± 0.001^{j}	7.5 ± 0.0^{a}	325 ± 1.0^{d}
	NR - 84292	448.91±5.37d	0.720 ± 0.001^{b}	7.9 ± 0.1^{a}	346 ± 1.0^{a}
	TMS – 30572	448.91±5.37d	0.630 ± 0.001^{e}	7.8 ± 0.1^{a}	330 ± 1.0^{c}
1000-2000	NR - 8082	428.83±0.79e	0.510 ± 0.001^{i}	7.5 ± 0.1^{a}	330 ± 1.0^{c}
	NR - 84292	428.83±0.79e	0.766 ± 0.001^{a}	8.0 ± 0.1^{a}	348 ± 1.0^{a}
	TMS – 30572	428.83±0.79e	0.675 ± 0.001^{d}	7.8 ± 0.1^{a}	340 ± 1.0^{b}

Within column, Mean ± SEM with different superscripts are significantly different at the P<0.05. Mean of 3 determinations

Table 5.0: Effect of thermal radiation on the Starch content and Hydrogen cyanide of freshly harvested cassava tubers and roasted gari (mg HCN equiv. Kg^{-1})

Flare distance (M)	Thermal Radiation (w/m2) Mean ± SEM	HCN in freshly peeled tubers Mean ± SEM mg HCN equiv. Kg^{-1}	Residual HCN in gari Mean ± SEM	Percentage Reduction of HCN Mean ± SEM	Per. Starch (%) Mean ± SEM
0-150	603.84±5.76a	142.74 ± 14.27^{a}	31.12 ± 3.29^{a}	77.57 ± 0.71^{e}	18.28 ± 0.003^{m}
150-300	588.40±4.0b	123.95 ± 13.00^{b}	24.52 ± 2.30^{b}	80.03 ± 0.83^{c}	37.98 ± 0.000^{j}
300-450	557.29±1.49c	108.66 ± 9.39^{c}	22.80 ± 2.70^{c}	79.57 ± 1.08^{d}	42.75 ± 0.003^{h}
450-600	448.91±5.37d	96.58 ± 8.09^{d}	15.68 ± 1.50^{d}	83.90 ± 0.23^{b}	44.67 ± 0.000^{f}
1000-2000	428.83±0.79e	94.43 ± 8.47^{d}	15.18 ± 1.46^{e}	83.97 ± 0.25^{a}	46.33 ± 0.003^{e}

Within column, Mean ± SEM with different superscripts are significantly different at the P<0.05

Table 6.0: Effect of Thermal radiation on the pH and % Total Titratable Acidity of cassava pulp and roasted gari

Flare distance (m)	Thermal Radiation (w/m2) Mean ± SEM	pH			Total titratable acidity (%TTA)		
		Zero hrs Mean ± SEM	72hrs Mean ± SEM	Freshly roasted gari Mean ± SEM	Zero hrs Mean ± SEM	78hrs Mean ± SEM	Freshly roasted gari Mean ± SEM
0-150	603.84±5.76a	7.03 ± 0.11^{a}	4.15 ± 0.01^{a}	4.03 ± 0.0^{a}	0.051 ± 0.011^{a}	1.000 ± 0.029^{a}	0.907 ± 0.106^{a}
150-300	588.40±4.0b	7.00 ± 0.03^{b}	4.10 ± 0.01^{b}	3.9 ± 0.1^{a}	0.042 ± 0.009^{b}	0.800 ± 0.014^{b}	0.817 ± 0.011^{a}
300-450	557.29±1.49c	6.70 ± 0.03^{d}	4.03 ± 0.02^{d}	3.7 ± 0.1^{a}	0.027 ± 0.006^{c}	0.799 ± 0.020^{c}	0.815 ± 0.025^{a}
450-600	448.91±5.37d	6.77 ± 0.04^{c}	4.07 ± 0.01^{c}	3.7 ± 0.1^{a}	0.017 ± 0.006^{d}	0.837 ± 0.030^{b}	0.840 ± 0.030^{a}
1000-2000	428.83±0.79e	6.70 ± 0.03^{d}	4.03 ± 0.01^{d}	3.7 ± 0.1^{a}	0.015 ± 0.006^{d}	0.830 ± 0.033^{b}	0.830 ± 0.033^{a}

Within column, Mean ± SEM with different superscripts are significantly different at the P<0.05
Mean of 3 determinations

Table 7.0: Effect of thermal radiation and cultivars on the sensory evaluation of roasted gari

Flare distance (m)	Cultivars	Thermal Radiation (w/m2) Mean ± SEM	Texture Mean ± SEM	Colour Mean ± SEM	Taste Mean ± SEM	General acceptability Mean ± SEM	Hand feel Mean ± SEM
0-150	NR - 8082	603.84±5.76a	4.0 ± 0.3^{f}	4.7 ± 0.1^{e}	5.0 ± 0.1^{e}	5.0 ± 0.1^{d}	4.8 ± 0.1^{d}
	NR - 84292	603.84±5.76a	4.7 ± 0.1^{ef}	5.0 ± 0.1^{e}	5.9 ± 0.1^{bc}	5.4 ± 0.1^{d}	5.2 ± 0.1^{d}
	TMS – 30572	603.84±5.76a	4.4 ± 0.2^{ef}	5.1 ± 0.1^{e}	4.9 ± 0.1^{e}	4.8 ± 0.1^{d}	5.0 ± 0.1^{d}
150-300	NR – 8082	588.40±4.0b	5.1 ± 0.1^{de}	6.0 ± 0.1^{cd}	5.0 ± 0.1^{e}	5.3 ± 0.1^{d}	6.2 ± 0.1^{bc}
	NR - 84292	588.40±4.0b	6.2 ± 0.1^{bc}	6.4 ± 0.1^{bc}	6.9 ± 0.1^{a}	6.1 ± 0.1^{c}	6.1 ± 0.1^{c}
	TMS – 30572	588.40±4.0b	5.6 ± 0.1^{cd}	5.8 ± 0.1^{d}	5.2 ± 0.1^{de}	5.3 ± 0.1^{d}	6.0 ± 0.1^{c}
300-450	NR - 8082	557.29±1.49c	5.9 ± 0.1^{cd}	6.1 ± 0.1^{cd}	5.4 ± 0.1^{cde}	6.1 ± 0.1^{c}	6.2 ± 0.1^{bc}
	NR - 84292	557.29±1.49c	6.3 ± 0.2^{bc}	6.8 ± 0.1^{ab}	6.9 ± 0.1^{a}	6.6 ± 0.1^{abc}	6.2 ± 0.1^{bc}
	TMS – 30572	557.29±1.49c	6.0 ± 0.1^{c}	6.0 ± 0.1^{cd}	6.6 ± 0.1^{a}	6.2 ± 0.1^{bc}	6.1 ± 0.1^{c}
450-600	NR - 8082	448.91±5.37d	6.4 ± 0.1^{bc}	6.6 ± 0.1^{b}	5.6 ± 0.1^{cd}	6.2 ± 0.1^{bc}	6.0 ± 0.1^{c}
	NR - 84292	448.91±5.37d	7.0 ± 0.1^{ab}	6.8 ± 0.1^{ab}	6.6 ± 0.1^{a}	6.8 ± 0.1^{ab}	6.7 ± 0.1^{ab}
	TMS – 30572	448.91±5.37d	6.3 ± 0.2^{bc}	6.6 ± 0.1^{b}	6.3 ± 0.1^{ab}	6.4 ± 0.1^{abc}	6.0 ± 0.1^{c}
1000-2000	NR - 8082	428.83±0.79e	6.4 ± 0.2^{bc}	6.8 ± 0.1^{ab}	6.6 ± 0.1^{a}	6.7 ± 0.1^{abc}	6.2 ± 0.1^{bc}
	NR - 84292	428.83±0.79e	7.8 ± 0.1^{a}	7.1 ± 0.1^{a}	6.8 ± 0.1^{a}	7.0 ± 0.1^{a}	6.8 ± 0.1^{a}
	TMS – 30572	428.83±0.79e	7.0 ± 0.1^{ab}	6.7 ± 0.1^{ab}	6.4 ± 0.1^{ab}	6.6 ± 0.1^{abc}	6.1 ± 0.1^{c}

Within column, Mean ± SEM with different superscripts are significantly different at the P<0.05. Mean of 3 determination.

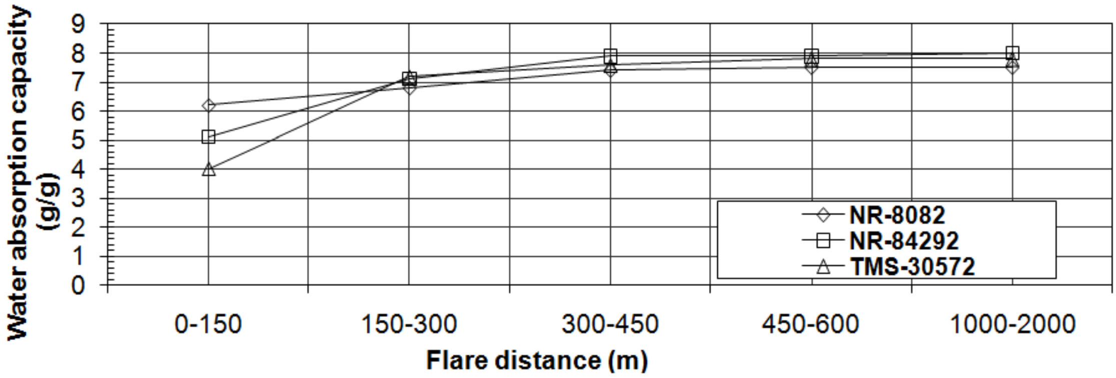

Fig. 2.0: Effect of flare distance and cassava cultivar on water absorption capacity (g/g) of roasted gari

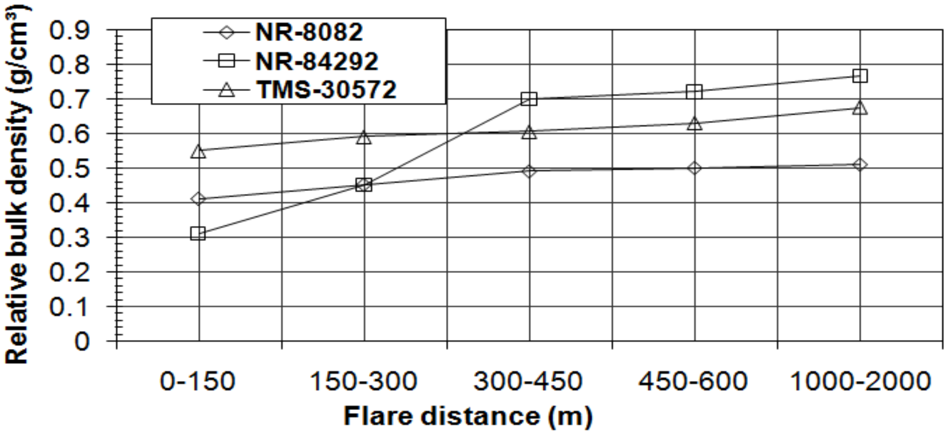

Fig. 3.0: Effect of flare distance and cultivar on relative bulk density (g/cm³) of roasted gari

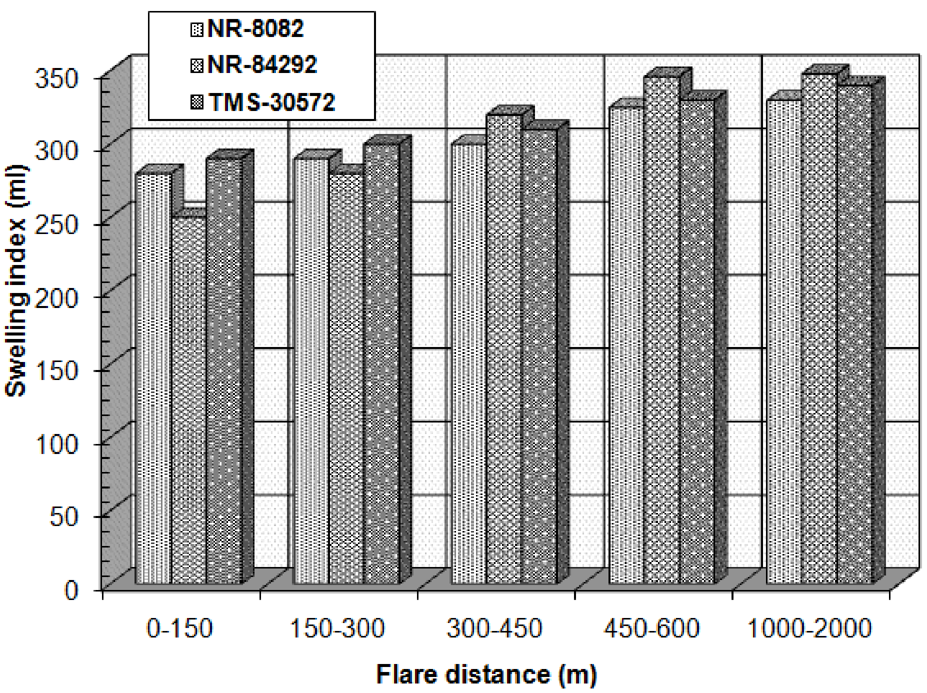

Fig. 4.0: Effect of flare distance and cassava cultivar on the swelling index (ml) of roasted gari

Total carbohydrate, had the highest value of 39.1% for NR-8082 at 300-450m (557.29±1.49c w/m2)and the least value of 17.8% for TMS-30572 at 1000-2000m(428.83±0.79e w/m2), Since the moisture content was low, the total carbohydrate (THC) value was consistently high at 0-150m for all the cultivars.The overall effect of the interaction of thermal radiation and cultivars on the proximate composition of freshly peeled cassava was significant (P<0.001).Under normal condition the effect of thermal stress appeared to have affected the protein content of fresh tubers at 0-150m, (603.84±5.76a w/m2) (1.18%), while the control point recorded protein value of (2.30%),

Effect of thermal radiation and cultivars on the proximate composition of gari from cassava grown around flare site was presented in Table 3.0. Gari made from TMS-30572 and NR-84292 had the highest moisture content (9.9 and 9.8%), while NR-8082 had the least moisture content of 9.6%. In Table 3.0 protein value ranged from 1.40-1.69% for gari made from TMS-30572 having the highest (1.69 ± 0.09%) and the least by NR-8082 (1.40 ± 0.07%.)

Table 3.0.shows that the crude fibre of gari from NR-30572 and NR-8082 with (1.59 and 1.60%),Crude fibre ranked highest (1.62 ± 0.08%) for NR-84292, shows no significant difference (P>0.05). Gari from NR-8082 contained the highest total carbohydrate (85.07%), closely followed by gari from NR-84292 and TMS-30572 (84.57% and 84.42%) respectively (Table 3.0).

The moisture of gari as presented (Table3.0) appeared to be within acceptable limit. Zuofa and Onuegbu[26] reported that dry gari with safe moisture content level of 12% could be preserved. [27]Achinewhu, [28]Almazan, and Achinewhu and Owuamanam,[23,] recommended quality specification for gari, moisture to be 3-10%, and the lower the moisture content, the longer the shelf life of gari. The low level of moisture content could be attributed to the effect of thermal stress which accounted for the low moisture content of freshly pealed cassava tubers at 0-150m (Table 2.0). Moisture content from 150-2000m flare distances showed no significant difference due to the effect of thermal stress (P>0.05)

The protein content (Table 3.0)appeared inadequate for human nutrition, fortification or supplementation with protein rich foods such as soybean, or groundnut flours as reported by Gomez *et al*., [29]. Also, the crude fibre content was low which compared with a range of 3.8 to 5.0 reported by Almazan [30] that is acceptable in gari. Thus, the lesser the fibre contents of gari, the better the quality. High fibre content has been implicated in the lowering of the enzyme lecithin-cholesterol acyl transferase (LCAT) activity that could be responsible for lipoprotein abnormalities found in communities that subsist on gari consumption, [31]. The effect of thermal radiation and cultivar on the proximate composition of gari was significant at the (P<0.001).

The effect of thermal stress on protein was also visible, as the protein content ranged from (1.15-1.90%) for 0-150m (603.84±5.76a w/m2) and 1000-2000m (428.83±0.79e w/m2), respectively. The protein content of gari increased as the distance from the flare increases and reduced thermal source.

Kay[31]reported that cassava tuber consists mainly of carbohydrate –above 90 percent on dry weight basis. Gomez *et al.,*[29]reported that the protein content is at most 3 percent and low in important amino acid, cysteine, and methionine. The fat ranges (0.5-0.6%) from 0-150m and 1000m-2000m for NR-84292, and NR-8082 and TMS-30572farms respectively. The fat content increased as the distance from the flare increased. Thus, the effect of thermal radiation and cultivars on fat was significant (P<0.001).

Crude fibre (1.83%) ranked highest at 0-150m, and least value of crude fibre (1.15%) recorded at 1000-2000m. According to Ononogbu and Okpara[32], the lesser, the crude fibre, the better the quality of the gari, thus, cassava grown at 0-150m appears to meet this quality. However, crude fibre is not the only parameters required of gari, thus, the overall effect of thermal stress oncrop yield was enormous and therefore farmers should exercise caution and restraint from cultivating crops at 0-150m perimeter/circumference of the flare zone.

Table 5.0 showed the effect of thermal radiation on starch content and Hydrogen cyanide of freshly crushed cassava tubers and roasted gari. Percentage starch content ranged from 18.28 to 46.33% with control point producing the highest starch value of 46.33% increase over starch content at 0-150m, with the lowest value. The effectthermal radiation on starch content was significant (P<0.001,) and the starch content increased as the distance from the thermal source increases. Starch fractions of 20-25% of the peeled were reported by Purseglove [33]. Further evaluation of the effect of thermal radiation and cultivars on starch quality should be investigated. Effects of thermal on Hydrogen cyanide level in cassava tubers and gari was studied in Table: 5.0

The hydrogen cyanide of the freshly peeled cassava roots ranged from 94.43 to 142.74 (mg HCN equivalent kg^{-1}) (Table 5.0) at 1000-2000m (428.83±0.79e w/m2), and 0-150m (603.84±5.76a w/m2) respectively. Going by 100mg HCN equivalent kg^{-1} for toxicity proposed by[34], the roots of these cultivars though from improved varieties still require processing before consumption so as to reduce the cyanide content to the safe level.

The residual cyanide content of gari produced ranged from 15.18 to 31.12 mg HCN equivalent kg^{-1} at 1000-2000m (428.83±0.79e w/m2), and at 0-150m (603.84±5.76a w/m2) respectively. The percentage reduction of cyanide showed that at 1000-2000m, the highest cyanide reduction value of 83.97% and at 0-150m; had the lowest value of77.57%.Thus, cyanide reduction was achieved through processing, residual cyanide(safe) level of 30mg HCN equivalent kg^{-1} has been reported by Akinrele *et al*, [35] and [23] as acceptable in gari. In considering the effect of flare distance (thermal stress) on hydrogen cyanide of peeled tubers and roasted gari (Table 5.0), cyanide level in peeled tubers was highest at 0-150m and lowest at 1000-2000m. It was observed that the cyanide content increased as the distance to the flare decreased and vice-versa. The trend was similar for roasted gari, where the residual cyanide in roasted gari also showed a lower value at 1000-2000m. The trend showed a significant effect on cyanide level (P<0.001).

Table 6.0 showed the effect of thermal radiation on the pH of cassava pulp and roasted gari at 0-150m (603.84±5.76a w/m2), the pH decreased from 7.03 (zero hour) to 4.15 (72 hours) and 4.03 for gari. Similarly, at 1000-2000m (428.83±0.79e w/m2), the pH of pulp and roasted gari decreased from 6.70 to 4.03 and 3.7 respectively at 72 hours. pH of gari agrees with the report of Achinewhu,[27], Achinewhu and Eke, [36]with pH range of 3.7 to 3.8 as adjudge satisfactory to good. The influence of pH and acids in the flavor characteristics of gari has been reported by Akinrele *et al.*[37.]

The effect of flare distance showed no significant difference (P>0.05) in the pH of roasted gari, but showed significant effect (P<0.05) in fermenting cassava pulp.

pH is important as a key sensory parameter imparting sour taste to gari showing complete fermentation. Achinewhu, (1994) stated thus, the sour taste of gari as appreciated by consumers is due to organic acids present in gari and this agreed with the work of Collard and Levi, [38].

Percentage titratable acidity (%TTA) of fermenting cassava mash and roasted gari as presented in (Table 6.0) was observed to increase as fermentation increased from 0.051 – 1.00% at Zero to 72 hours at flare distance of 0-150m(603.84±5.76a w/m2). At 1000-2000m (428.83±0.79e w/m2), the control, %TTA increased from 0.015 to 0.830% in 72 hours. It was observed that the percentage titratable acidity of pulp from cultivars around 0-150m flare distance was very high as earlier reported in (Table 6.0), the pH decreased, while the titratable acidity increased (Table 6.0) during the 72 hours fermentation. This is due to the production of organic acids namely lactic, acetic, propionic, succinic, pyruvic acid and other compounds such as esters and aldehydes produced by fermentative organisms such as Corynebacterium *manihot* and Geotrichum *candidum*, both of which attack starch with the production of organic acids [38], [37].

The effect of flare distance showed a considerable increase over 0-72hours in the pulp at 0-2000m flare distance and thus shows no significant effect (P>0.05) in roasted gari. However, the effect of flare (thermal stress) was significant during the fermentation period of 72 hours (P<0.001). This could be attributed to the production of acids by microorganisms and the varietal influence of cultivars as reported by Collard and Levi,[38.]

The effect of cultivars shows a significant effect on the physical properties of roasted gari. Sensory evaluation of roasted gari due to the effect of Thermal radiation and cultivar is presented in Table 7.0. The mean separation showed a significant difference for texture, colour, taste, general acceptability and hand feel (P<0.001). However, gari from NR-84292 at 1000-2000m (428.83±0.79e w/m2), was most preferred in texture, colour, taste, and general acceptability and hand feel to other cultivars at different flare distances. Cultivars within 0-150m (603.84±5.76a w/m2) were least preferred in terms of the sensory parameters such as texture, colour, taste, general acceptability and hand feel. This most probably could be due to the high thermal stress (603.84±5.76a w/m2)associated with cultivars grown around the flare site, which makes the tubers very fibrous and thus affects the overall sensory parameters. Preference for the sensory parameters increased as the distance from the flare increased with the resulting cultivars.

At 150-300m (588.40±4.0b w/m2) , NR-84292 had a preferred value compared to those at 0-150m in terms of texture, colour, taste, general acceptability and hand feel. Considering the effect of flare distance on the sensory evaluation of roasted gari from some cassava cultivars as presented in (Table 7.0), texture, colour, taste, general acceptability and hand feel of roasted gari at 1000-2000m were highly preferred to others at different flaring distance.

However, all the sensory parameters of roasted gari showed significant difference due to the effect of flare distance (P<0.001), Table 7.0 showed the effect of cultivars on the sensory evaluation of gari grown around flare site. NR-84292 showed high preference to taste, general acceptability and hand feel. This was closely followed by NR-8082 and TMS-30572 , except for texture, where TMS-30572 was preferred.

Cultivars showed a significant effect on the sensory parameters. Gari from NR-84292 tend to be preferred in terms of sensory parameters to NR-8082 and TMS –30572 which could be attributed to the variety since NR-84292 is a sweet cultivar. Thus pH and total titratable acidity that had no significant difference could not be used to differentiate their sensory performance. However, TMS-30572 with high yield was preferred to NR-8082, Achinewhu [27] reported that in the sweet variety, the toxic linamarin tend to be concentrated in the skin and the outer cortical layer of the sweet cassava peel.

Table 4.0 showed the effect of thermal radiation and cultivars on physical properties of roasted gari. Water absorption capacity, the value ranged from 4.0 ± 2.0^c to 8.0 ± 0.1^a. The relative bulk density g/cm^3 of gari ranged from $0.310 \pm 0.001^{n-t}$ to 0.766 ± 0.001^a at 603.84±5.76a w/m2 and 428.83±0.79e w/m2 radiation level respectively with and 428.83±0.79e w/m2 had the highest value (0.766 ± 0.001^a) of relative bulk density.

The swelling index (ml) ranged from 250 ± 1.0[j] to 348 ± 1.0[a]. Water absorption capacities, Relative bulk density and Swelling index showed significant difference for the various radiation levels as showed in Table 4.0

(Figure 2.0 and Table.4.0) showed the water absorption capacity (g/g) of gari from three cultivars at different flaring distance, NR-84292 at 1000-2000m had the highest water absorption capacity of (7.8 (g/g)), NR-8082 (7.5 (g/g)) and TMS-30572 (7.8 (g/g)). At 0-150m, TMS-30572 had the least water absorption capacity (4.0 (g/g)). The water holding capacity was influenced by the amount of denatured protein and the starch fraction partially dextrinized during roasting, which are in agreement with the work of Rosario and Flores[39], who reported influence of denatured protein on water holding capacity of flours. NR-84292 and TMS-30572 with protein and starch contents 2.0% and 48.14%; 1.90% and 45.94% respectively at 1000-2000m flare distance had the highest water absorption capacity (Table 4.), which agreed with the work of Achinewhu and Owuamanam,[23] under normal condition. While the least water absorption capacity was observed at 0-150m by NR-8082 and TMS-30572 with protein and starch content of 1.10% and 16.0%, and 1.15% and 18.44% respectively. It was observed that the gari absorption capacity increases as you moved away from the flare source. Influence of flare distance and cultivars showed no significant difference on the water absorption capacity ($P>0.05$),

The effect of flare distance and cultivars on the physical properties of roasted gari was presented in (Figure 3.0 and Table. 4.0). At 1000-2000m, NR-84292 had the highest bulk densities (0.766g/cm^3) and lowest 0.310 g/cm^3 at 0-150m. The values for the relative bulk density increased as the distance from the flare increases. The value of the relative bulk density for TMS-30572 closely followed NR-84292 through the flare distance. Gari with the highest relative bulk density had the most even distribution of the gari grains. This finding agreed with the work of Achinewhu and Owuamanam, [23.] The grain size of gari is affected by the rate of agglomeration of the partially gelatinised cassava mash during roasting. Intermittent scrubbing between the floor of the frying pan to disintegrate lumpy sections of the meal controls agglomeration. [3]Onwueme reported the need to separate final product into various particle sizes, chaffy, fine medium and large fractions for quality specification.Figure 4.0 showed that the effects of flare distance and cultivars on the swelling index. Swelling capacities of gari ranged from 348 (ml) for NR-84292 at 1000-2000m to 250 (ml) for NR-84292 at 0-150m, showing significant effect of flare distance on the physical properties of gari ($P<0.001$)

In Figure 4.0,and Table.4.0 the swelling index increased as the cultivars are far apart from the flare source and this aligned with Volume increases of 300-500% reported by Achinewhu,[27] as acceptable for a quality gari. Thus gari at 0-150m, flare distance had lower swelling index due to the influence of thermal stress on protein and starch contents.

The volume increase of gari when soaked in hot or cold water is due to the partial dextrinization of starch during roasting so that when the product is put in water, it swells considerably[3]. That could be the reason why NR-84292 and TMS-30572 with high volume increase of 348% had starch contents of 48% and 45% respectively.

IV. CONCLUSION AND SUMMARY

This research showed that the effect of thermal radiation on the proximate composition of gari was significant. The effect of thermal radiation and cultivars showed no significant difference on the water absorption capacity; however, the effect on swelling index was significant ($P<0.05$). The effect thermal radiation on starch content was significant ($P<0.001$,) and the starch content increased as the distance from the thermal source increases. The percentage reduction of cyanide showed that at 1000-2000m, the highest cyanide reduction value of 83.97% and at 0-150m; had the lowest value of77.57%.Thus, cyanide reduction was achieved through processing.

Finally, in considering the effect of flare (thermal stress) on sensory parameters, TMS-30572 and NR-8082 with high yield were preferred in overall general acceptability to NR-84292. The effect of thermal radiation and cultivar on the proximate composition of gari was significant at the ($P<0.001$).This work provides an escort into allaying the fears of the rural farmers over poor quality cassava products in terms of its physico-chemical and sensory parameters resulting from cassava grown around gas installation and flare sites. From this study, the most preferred distance of planting should be from 300-450m away from the thermal source.

In view of this study, NR-8082 and TMS-30572 are being recommended to farmers due to heat tolerant level at the 0-150m and high gari yield at the control plot at 1000-2000m. More other improved cultivars should be introduce and studied for wider range of adaptability and use.

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