EFFECT OF AGE AT HARVEST, CROPPING SYSTEM AND VARIETY ON SOME ATTRIBUTES OF HIGH QUALITY CASSAVA FLOUR

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INTRODUCTION

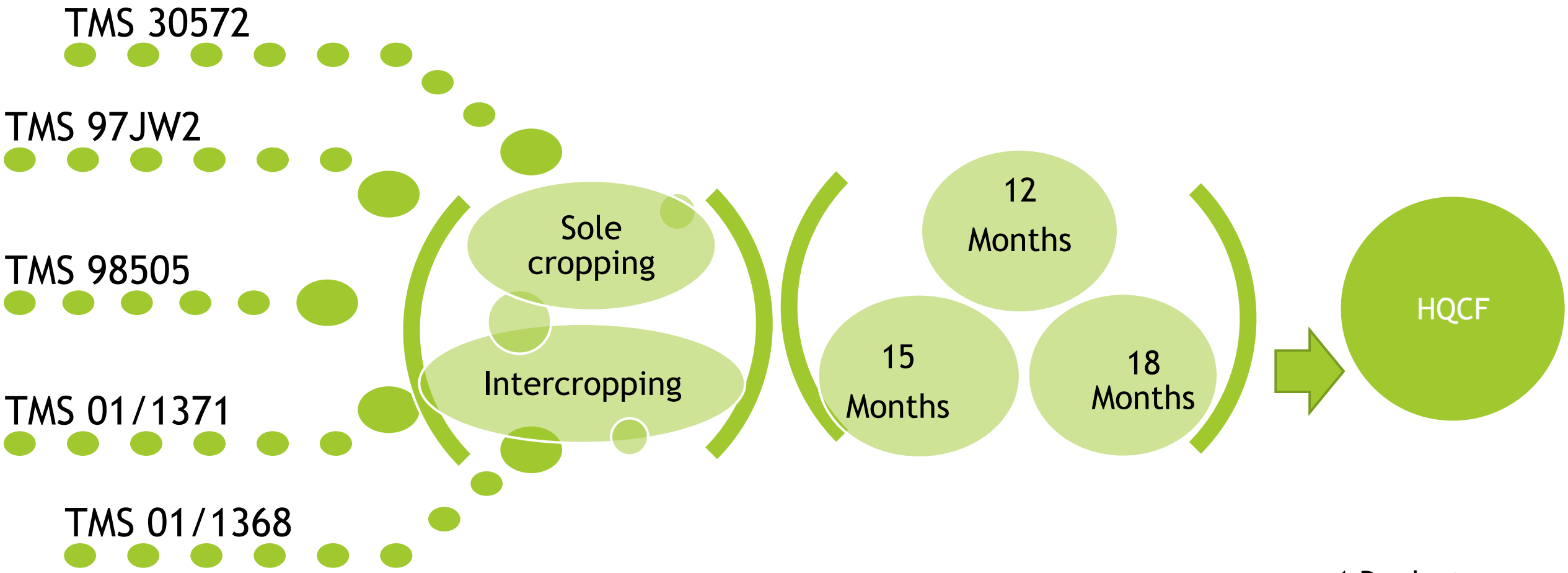
- Cassava (*Manihot esculenta* Crantz) (Nweke *et al*., 2002).
  - Production (IITA, 2015).
  - Perishability (Beeching *et al*., 2002).
  - Harvesting (FAO, 2006)
  - Cultural practices (Cameron *et al*., 2008) and (Wiesler *et al*., 2010)
  - Cassava varieties
- High Quality Cassava Flour (HQCF) (Sanni *et al*., 2009)
  - Uses of HQCF
  - Government policy

OBJECTIVE

The objective of this study therefore was to evaluate the impact of age at harvest (AH), cropping system (CS) and variety on some attributes of HQCF

MATERIALS AND METHODS

MATERIALS



5 Cassava Varieties

2 Cropping Systems

3 Age at harvest

1 Product

(Adekunle *et al.*, 2012)

- *Chemical Analyses*
  - Determination of proximate composition (AOAC, 2000)
  - Determination of mineral matter
- *Determination of functional properties*
  - Swelling power and solubility index (Leach *et al*., 1959)
  - Determination of water absorption index (Nwosu *et al*., 2010)
  - Determination of bulk density (Akpapunam and Markakis, 1981)
  - Determination of dispersibility (Kulkarni, 1991)
  - Determination of pasting properties (Rapid Visco Analyser-Tecmaster, Pertens Instruments, Australia)

➢*Determination of physicochemical properties*

- Determination of pH (AOAC, 2000)
- Determination of total titratable acidity (AOAC, 2000)
- Colour analysis (Chroma Meter: CR-410; Konica Minolta, INC, Japan)

➢*Data Analysis*

- Data were analysed using General Linear Model (GLM) on Statistical Analysis System (SAS, 2013).

RESULTS AND DISCUSSION

Table 1: Proximate Composition of HQCF as Affected by Age at Harvest, Cropping System and Variety of Cassava Roots

Age at Harvest	Cassava Variety	Cropping System (CS)	Moisture (%)	Ash (%)	Crude Fibre (%)	Protein (%)	Fat (%)	CHO (%)
12	TMS	Intercropping	5.80	1.00	0.40	0.69	0.09	92.02
Months	30572	Sole cropping	5.50	1.00	0.23	0.67	0.25	92.35
	TMS	Intercropping	4.40	1.50	0.11	0.44	0.08	93.47
	97JW2	Sole cropping	5.90	1.50	0.16	0.41	0.19	91.84
	TMS	Intercropping	5.10	1.50	0.22	0.54	0.10	92.54
	98505	Sole cropping	3.60	1.50	0.20	0.60	0.10	94.00
	TMS	Intercropping	8.30	1.75	0.10	0.43	0.18	89.24
	01/1371	Sole cropping	4.30	2.00	0.41	0.77	0.08	92.44
	TMS	Intercropping	6.30	1.50	0.13	0.46	0.14	91.47
	01/1368	Sole cropping	4.90	1.75	0.29	0.57	0.15	92.34
15	TMS	Intercropping	5.10	1.25	0.09	0.46	0.11	92.99
Months	30572	Sole cropping	6.20	1.00	0.04	0.41	0.56	91.79
	TMS	Intercropping	5.10	1.25	0.12	0.53	0.65	92.35
	97JW2	Sole cropping	6.60	1.00	0.12	0.40	0.12	91.76
	TMS	Intercropping	5.10	1.00	0.13	0.45	0.87	92.45
	98505	Sole cropping	6.00	1.00	0.12	0.41	0.15	92.32
	TMS	Intercropping	5.30	1.75	0.07	0.33	0.26	92.29
	01/1371	Sole cropping	6.20	1.50	0.12	0.35	0.25	91.58
	TMS	Intercropping	5.40	1.25	0.10	0.45	0.38	92.42
	01/1368	Sole cropping	5.30	1.00	0.13	0.43	0.13	93.01
18	TMS	Intercropping	8.07	1.78	0.04	0.65	0.14	89.32
Months	30572	Sole cropping	7.08	1.75	0.06	0.66	0.38	90.07
	TMS	Intercropping	7.65	1.68	0.13	0.68	0.34	89.52
	97JW2	Sole cropping	8.15	1.75	0.12	0.55	0.97	88.46
	TMS	Intercropping	7.75	1.53	0.12	0.52	0.28	89.80
	98505	Sole cropping	9.16	1.93	0.06	0.36	0.52	87.97
	TMS	Intercropping	7.41	4.30	0.15	0.74	0.36	87.04
	01/1371	Sole cropping	8.43	3.08	0.28	0.33	0.77	87.11
	TMS	Intercropping	8.44	3.18	0.21	0.97	0.45	86.75
	01/1368	Sole cropping	8.47	2.78	0.11	0.56	0.13	87.95
		Range	3.60-9.16%	1.00-4.30%	0.04-0.41%	0.33-0.97%	0.08-0.97%	86.75-94.00%
		LSD	0.511	0.188	0.027	0.049	0.007	0.583
		Age	***	***	***	***	***	***
		CS	ns	ns	***	ns	***	ns
		Variety	ns	***	***	***	***	***
		Age*CS	ns	ns	***	***	***	ns

Table 2: Mineral composition of HQCF as affected by age at harvest, cropping pattern and variety

Age of Harvest	Cassava Variety	Cropping Pattern (CP)	Manganese (mg/Kg)	Magnesium (mg/Kg)	Iron (mg/Kg)	Potassium (mg/Kg)	Sodium (mg/Kg)
12 Months	TMS	Intercropping	2.00	213.30	ND	30.20	50.50
	30572	Sole cropping	4.10	208.20	ND	ND	66.50
	TMS	Intercropping	3.90	194.90	1.70	11.60	79.60
	97JW2	Sole cropping	3.20	186.80	9.40	14.70	63.60
	TMS	Intercropping	2.40	221.30	1.00	20.40	56.90
	98505	Sole cropping	1.70	203.90	ND	5.70	72.20
	TMS	Intercropping	3.80	227.10	ND	20.90	114.10
	01/1371	Sole cropping	4.30	228.00	ND	2.70	95.50
	TMS	Intercropping	1.80	215.50	20.20	9.10	40.30
	01/1368	Sole cropping	2.00	222.00	14.40	23.40	58.60
15 Months	TMS	Intercropping	1.80	48.60	ND	293.20	31.70
	30572	Sole cropping	3.10	52.90	ND	269.80	9.80
	TMS	Intercropping	2.00	48.70	1.70	279.60	5.00
	97JW2	Sole cropping	2.70	45.10	14.40	274.40	ND
	TMS	Intercropping	2.60	49.90	ND	272.70	31.60
	98505	Sole cropping	2.60	49.70	ND	300.20	34.60
	TMS	Intercropping	1.60	49.40	1.00	273.80	ND
	01/1371	Sole cropping	3.00	52.80	20.20	284.60	30.40
	TMS	Intercropping	2.20	49.20	9.40	274.00	14.60
	01/1368	Sole cropping	2.50	51.80	ND	262.70	22.90
18 Months	TMS	Intercropping	1.40	55.40	9.30	905.00	195.70
	30572	Sole cropping	0.40	52.60	1.60	0.60	176.30
	TMS	Intercropping	1.30	53.50	4.40	842.20	79.30
	97JW2	Sole cropping	1.30	53.60	7.30	873.00	51.80
	TMS	Intercropping	0.70	48.70	11.20	785.50	59.90
	98505	Sole cropping	0.80	50.10	5.90	862.80	69.00
	TMS	Intercropping	1.40	56.90	6.60	956.60	140.20
	01/1371	Sole cropping	2.10	51.10	11.40	927.70	212.30
	TMS	Intercropping	1.00	55.00	5.40	911.80	153.40
	01/1368	Sole cropping	0.10	59.10	6.90	806.00	78.50
		Range	0.10 - 4.30	45.10 - 228.00	1.00 - 20.20	0.60 - 956.60	5.00 - 212.30
		LSD	0	0	0	0	0
		Age	***	***	***	***	***
		CP	***	***	***	***	***
		Variety	***	***	***	***	***
		Age*CP	***	***	***	***	***

Table 3: The pH, TTA and colour of HQCF as affected by age at harvest, cropping pattern and variety

Age of Harvest (Months)	Cassava Variety	Cropping Pattern (CP)	pH	TTA (%)	L*	a*	b*
12	TMS	Intercropping	6.88	0.16	108.81	0.68	14.21
	30572	Sole cropping	7.24	0.09	113.48	0.62	14.51
	TMS	Intercropping	6.49	0.34	117.07	0.38	12.91
	97JW2	Sole cropping	8.51	0.23	104.59	0.24	14.30
	TMS	Intercropping	8.04	0.38	106.75	0.43	13.10
	98505	Sole cropping	8.93	0.34	99.55	0.40	12.19
	TMS	Intercropping	8.15	0.04	108.22	0.53	16.83
	01/1371	Sole cropping	8.69	0.05	114.32	0.54	16.63
	TMS	Intercropping	6.37	0.20	107.56	0.84	14.19
	01/1368	Sole cropping	7.85	0.11	116.16	0.57	14.66
15	TMS	Intercropping	4.90	0.18	112.61	0.76	10.91
	30572	Sole cropping	6.97	0.03	112.59	0.76	10.87
	TMS	Intercropping	5.35	0.21	116.45	1.25	13.92
	97JW2	Sole cropping	4.98	0.18	118.80	1.13	11.48
	TMS	Intercropping	4.73	0.17	117.05	1.14	11.31
	98505	Sole cropping	7.01	0.05	113.26	0.87	12.36
	TMS	Intercropping	6.14	0.06	117.54	0.91	9.90
	01/1371	Sole cropping	7.09	0.03	114.32	1.89	13.73
	TMS	Intercropping	4.82	0.21	118.07	0.78	10.28
	01/1368	Sole cropping	6.27	0.07	118.53	1.30	11.61
18	TMS	Intercropping	6.43	0.13	103.71	1.20	16.59
	30572	Sole cropping	6.50	0.18	105.25	1.06	15.18
	TMS	Intercropping	5.02	0.38	101.88	2.24	21.13
	97JW2	Sole cropping	5.31	0.29	103.46	2.25	20.90
	TMS	Intercropping	4.79	0.45	100.45	0.56	13.68
	98505	Sole cropping	8.80	0.36	108.11	1.33	14.26
	TMS	Intercropping	5.45	0.41	98.75	2.39	28.03
	01/1371	Sole cropping	7.12	0.07	108.32	1.34	17.95
	TMS	Intercropping	8.46	0.04	98.39	1.42	16.52
	01/1368	Sole cropping	6.50	0.13	101.26	0.95	14.09
		Range	4.73-8.93	0.03 - 0.45	98.39 - 118.80	0.24 - 2.39	9.90 - 28.03
		LSD	0.0419	0.0419	0.2733	0.049	0.1652
		Age	***	***	***	***	***
		CP	***	***	ns	***	ns
		Variety	***	***	***	***	***

Table 4: Functional properties of HQCF as affected by age at harvest, cropping pattern and variety

Age at Harvest (Months)	Cassava Variety	Cropping Pattern (CP)	Water Absorption Index (%)	Bulk Density (g/ml)	Dispersibility (%)	Swelling Power	Solubility Index (%)
12	TMS	Intercropping	120.80	0.67	66.50	7.10	31.50
	30572	Sole cropping	117.60	0.67	70.00	8.22	36.00
	TMS	Intercropping	130.40	0.65	67.50	8.08	24.00
	97JW2	Sole cropping	115.20	0.65	71.00	8.48	32.00
	TMS	Intercropping	116.00	0.63	71.00	7.96	28.00
	98505	Sole cropping	116.80	0.74	71.50	9.47	28.00
	TMS	Intercropping	142.40	0.65	65.00	8.43	28.00
	01/1371	Sole cropping	140.80	0.71	59.00	7.09	33.00
	TMS	Intercropping	118.00	0.67	70.00	6.18	26.00
	01/1368	Sole cropping	123.60	0.63	69.00	8.50	23.50
15	TMS	Intercropping	140.00	0.67	69.00	7.01	11.00
	30572	Sole cropping	130.80	0.70	65.00	7.99	16.00
	TMS	Intercropping	138.00	0.67	65.00	7.49	13.50
	97JW2	Sole cropping	144.00	0.66	68.00	7.71	17.00
	TMS	Intercropping	158.40	0.65	66.00	8.41	17.50
	98505	Sole cropping	148.00	0.67	65.00	8.09	14.00
	TMS	Intercropping	141.20	0.67	59.50	7.70	15.50
	01/1371	Sole cropping	164.80	0.71	55.50	7.62	11.50
	TMS	Intercropping	140.80	0.67	69.00	7.17	9.50
	01/1368	Sole cropping	153.20	0.65	68.00	8.03	11.00
18	TMS	Intercropping	136.00	0.66	62.00	6.12	1.00
	30572	Sole cropping	144.00	0.69	66.00	6.20	1.50
	TMS	Intercropping	124.00	0.70	65.50	6.76	3.50
	97JW2	Sole cropping	136.00	0.71	64.50	6.10	4.00
	TMS	Intercropping	128.00	0.77	67.00	6.00	2.50
	98505	Sole cropping	136.00	0.73	61.00	6.74	1.00
	TMS	Intercropping	192.00	0.67	48.00	6.88	3.50
	01/1371	Sole cropping	188.00	0.67	56.00	7.67	3.00
	TMS	Intercropping	144.00	0.71	62.00	7.17	2.50
	01/1368	Sole cropping	172.00	0.71	56.50	6.93	2.00
		Range	115.20-192.00	0.63-0.77	48.00-71.50	6.00-9.47	1.00-36.00
		LSD	2.7366	0.0071	0.6192	0.2245	1.2231
		Age	***	***	***	***	***
		CP	ns	***	ns	***	ns
		Variety	***	***	***	***	***

Table 5: Pasting properties of HQCF as affected by age at harvest, cropping pattern and variety

Age of Harvest (Months)	Cassava Variety	Cropping Pattern (CP)	Peak Viscosity (RVU)	Trough (RVU)	Break- down (RVU)	Final Viscosity (RVU)	Setback (RVU)	Peak Time (min)	PT (°C)
12	TMS	Intercropping	245.29	127.63	117.67	165.79	38.17	4.10	75.13
	30572	Sole cropping	171.42	84.29	87.13	115.88	31.58	4.27	77.08
	TMS	Intercropping	279.83	152.71	127.13	210.13	57.42	4.33	75.98
	97JW2	Sole cropping	285.42	129.71	155.71	179.04	49.33	4.17	77.55
	TMS	Intercropping	325.92	138.92	187.00	190.75	51.83	4.20	76.70
	98505	Sole cropping	338.75	146.25	192.50	191.29	45.04	4.44	78.75
	TMS	Intercropping	285.13	181.21	103.92	253.75	72.54	4.40	76.28
	01/1371	Sole cropping	289.08	143.96	145.13	194.13	50.17	3.93	74.65
	TMS	Intercropping	193.71	103.83	89.88	140.67	36.83	4.17	76.65
	01/1368	Sole cropping	336.50	134.88	201.63	186.17	51.29	3.97	75.88
15	TMS	Intercropping	299.88	144.38	155.50	196.50	52.13	4.27	75.08
	30572	Sole cropping	283.33	129.54	153.79	192.96	63.42	4.33	76.30
	TMS	Intercropping	331.33	165.29	166.04	226.54	61.25	4.07	76.33
	97JW2	Sole cropping	357.13	160.29	196.83	219.13	58.83	4.24	75.90
	TMS	Intercropping	278.75	135.88	142.88	194.21	58.33	4.27	76.70
	98505	Sole cropping	330.25	136.92	193.33	199.33	62.42	4.07	75.58
	TMS	Intercropping	330.29	159.21	171.08	226.08	66.88	4.37	75.13
	01/1371	Sole cropping	355.50	192.08	163.42	261.92	69.83	4.63	74.25
	TMS	Intercropping	404.42	181.88	222.54	240.04	58.17	4.04	75.88
	01/1368	Sole cropping	347.83	157.17	190.67	226.29	69.13	4.37	77.03
18	TMS	Intercropping	266.21	124.58	141.63	180.17	55.58	4.34	75.50
	30572	Sole cropping	282.38	121.92	160.46	169.04	47.13	4.27	75.88
	TMS	Intercropping	283.96	141.21	142.75	194.96	53.75	4.37	77.88
	97JW2	Sole cropping	297.50	156.33	141.17	207.75	51.42	4.40	76.63
	TMS	Intercropping	293.25	162.29	130.96	166.79	46.17	4.50	76.73
	98505	Sole cropping	322.54	130.08	192.46	196.42	66.33	4.60	77.08
	TMS	Intercropping	290.42	181.96	109.21	246.38	65.17	5.27	74.65
	01/1371	Sole cropping	318.21	244.92	73.29	328.88	83.96	5.54	76.68
	TMS	Intercropping	323.33	153.33	170.00	214.63	61.29	5.10	74.50
	01/1368	Sole cropping	353.25	215.79	137.46	277.71	61.92	5.17	76.25
		Range	171.42 - 404.42	84.29 - 244.92	73.29 - 222.54	115.88 - 328.88	31.58 - 83.96	3.93 - 5.54	74.25 - 78.75
		LSD	14.768	10.434	11.017	14.345	4.0868	0.1319	1.8246
		Age	***	ns	***	ns	ns	***	ns
		CP	ns	ns	ns	ns	ns	ns	ns
		Variety	ns	ns	***	ns	ns	ns	ns
		Age*CP	ns	ns	ns	ns	ns	ns	ns
		Age*Variety	ns	ns	ns	ns	ns	ns	ns
		Variety*CP	ns	ns	ns	ns	ns	ns	ns
		Age*Variety*CP	ns	ns	ns	ns	ns	ns	ns

CONCLUSION

- Age at harvest had significant ($p < 0.05$) effect on most of the quality attributes of HQCF except some of the pasting properties
- Therefore, age at harvest is an important factor to be put into consideration with the quality of the final product in mind
- Cropping system did not have significant ($p < 0.05$) effect on the proximate composition (except fat) and pasting properties of HQCF
- Varietal differences affected most of the attributes in HQCF and therefore should be considered before cultivation with the final use of the cassava roots in view

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