Quality characteristics of hot pepper (*Capsicum chinense*) powder in relation to the drying and milling regimes

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Abstract: Quality characteristics of hot pepper powder in relation to drying temperatures and milling regimes was determined using hot air oven at temperatures (80°C, 85°C, 90°C and 95°C) and milled using attrition mill for 5 and 10 minutes. The quality parameters determined are particle size distribution using sieve method, bulk density using pack and loose method, colour using spectrophotometry and CIELab method, pungency using spectrophotometric method, reconstitution index using soaking method and sensory attributes using seven hedonic scale. The percentage particle size distribution was as follows: 1.40 mm aperture size ranging from 1.39-0.31, 0.425 mm size ranging from 2.55-36, 0.210 mm size ranging from 50.25-79.87, 0.150 size ranging from 2-27, and for 0.090 mm size ranging from 0.016-9.8. The pack bulk density (g m^{-3}) of hot pepper powder was dried and milled and ranged from 0.62 - 0.57 for (80°C: 5 minutes and 95°C:5 minutes) and 0.58, 0.52 (80°C:10 minutes and 95°C:10 minutes). The loose bulk density (g m^{-3}) ranged from 0.45- 0.44 for (80°C:5 minutes and 90°C:5 minutes) and 0.49- 0.39, (90°C:10 minutes and 85°C:10 minutes). The chemical or extractable colour content in ASTA unit the colour is ranged from 2594.90 (80°C: 10minutes) to 2357.83 (90°C :5 minutes).The visual colour of the surface colour is ranged from, L* for brightness, 13.56 (90°C:5 minutes) to 23.43 (95°C:10 minutes); a* for redness, 17.45, to 36.80, for 80°C:10 minutes and 85°C:5 minutes respectively; b* for yellowness, 21.53 (80°C:5 minutes) to 61.36 (85°C:5 minutes). The pungency(capsaicin) content (SHU) of hot pepper powder ranged from 32595 (85°C:5minutes) to 40745 (90°C:10 minutes); reconstitution index ranged from 7.00 for 85°C:5 minute to 9.40 for 90°C:10 minutes of the hot pepper. Hot pepper dried at 90°C and milled for 5 minutes was generally accepted.

Keywords: drying, temperature, milling, quality, hot pepper

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1 Introduction

Hot pepper (*Capsicum chinenses*) is a pepper specie belonging to the family of Solanaceae of class Capsicum (Berke and Shieh, 2001). In Nigeria, hot pepper is referred to as '*atarhu*' in Hausa, '*atarodo*' in Yoruba. it is used as spices in preparing soups, sauces, spicy dishes or it used as medicines, cosmetics and plant insecticides (Take-Ajaykumar et al., 2012; Dognoko, 2013). Fresh peppers may be stored for up to 3 weeks in cool, moist conditions (45–50°F and 85–90 percent relative humidity) (ISU, 2009). Peppers are commonly dried for spice production. The dried spice is used in food mixtures, salad dressings, instant soups, frozen pizzas and many other convenience foods. Peppers are also a source of minerals such as calcium, phosphorous, potassium and iron (Faustino et al., 2007).

Most fruits and vegetables production in Nigeria are seasonal. Studies have shown that about 30% of fruits and vegetables produced are lost along the distribution chain (Tunde-Akintunde and Akintunde, 1996; Idah et al., 2010).

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Hot air drying has been till date the method of drying industrial scale of pepper in Nigeria and other part of the world. (Tunde-Akintunde et al., 2005). According to local producers, sun dehydration of pepper requires about seven consecutive days and the fruits suffer undesirable fermentation, with consequent reduction in the sales due to poor colour, aroma, dust and microbial infection (Soysal et al., 2009). This process is slow, requires a deal of care and thus is not feasible once the actual quality of product is not competitive. Hot air drying (HD) is popular for drying chilli due to a relatively short drying time, uniform heating and more hygienic characteristics. The temperature ranges from 45°C to 70°C (approximately 10% of moisture content), and this reduces drying time to less than 20 hours. This temperature range gives maximum colour values and minimizes the loss of volatile oils and discolouration. Long drying periods lead to poor quality of final products and as such conditions are sought that result in higher drying rates, acceptable final products that are economically viable. (Tunde-Akintunde and Afolabi, 2010).

Milling involves the application of external force; the amount of particles reduction caused by the external forces depend on the amount of energy applied to the particle, the rate at which it is applied (Wennerstrum et al., 2002). Grinding facilitates the release of aroma/flavour principles and better uniform mixing with food materials. At the same time, grinding of spices results in considerable loss of aroma due to the heat generated (42°C to 95°C) during conventional grinding (Gopalakrishnan et al., 1991),

Many factors such as cultivar, temperature of drying, oxygen/air atmosphere, temperature, and moisture content during processing affects the retention of quality, the physicochemical and sensory quality characteristics of a product such are influenced by drying and milling therefore the evaluation of the milling regimes and drying characteristics has to be crop specific.

The aim of these research is to determine the effect of drying temperatures and milling regimes on the quality of hot pepper powder., as a function of drying/milling conditions could help in predicting suitable drying/ milling conditions on the quality of product.

2 Material and Methods

Samples were purchased from the Jos central market in Plateau state (Latitude: 9.8965° N, latitude 8.8583° E) of Nigeria and was transported to laboratory of Food Science and Technology, Kano University of Science and Technology, Wudil, Kano state (latitude: 11.7942° N, longitude: 8.8390° E) the fresh hot pepper was cleaned, sorted, cut to approximately 2 cm in diameter and oven dried at varying temperatures (hot air oven at 80°C, 85°C, 90°C and 95°C) until 10% moisture was attained. The dried samples were milled using attrition for 5 and 10 minutes.

2.1 Measurement of Physical and Chemical Qualities

2.1.1 Determination of moisture content

The moisture content of the pepper was determined according to the official method of the AOAC (2012). Five grams of granular sample was weighed in to a crucible and placed in to an air oven at 105°C for 1 hour. The crucible plus the sample was allowed to cool in desiccators and reweighed afterwards. The moisture content was then calculated as

$$\text{moisture content} = \frac{\text{Weight of dried samples}}{\text{Weight of fresh sample}} \times 100 \quad (1)$$

2.1.2 Particle size distribution

The particle size distribution will be determined using the sieve analysis as adopted by Onwuka (2005). 20 g pepper was passed through a sieve with varying aperture ranging from 1.40 mm, 425 ųm, 210 ųm, 150 ųm and 90 ųm and it was agitated for 30 minutes using a vibratory shaker after sieving samples from each sieves collected were weighed.

The % particle size distribution=

$$\frac{\text{Weight of dried samplesweight of samples collected by sieve}}{\text{Weight of sample}} \text{ x } 100 \quad (2)$$

2.2 Bulk density

2.2.1 Loose bulk density

The bulk density was determined by the method described by Malomo et al. (2012). In 10 mL graduated measuring cylinder, sample was packed without agitation/tapping to the calibration of 10 mL the sample was then weighed to obtain loose bulk density.

Loose Bulk density (g mL^{-1}) =

$$\frac{\text{Weight of the sample after packing}}{\text{Volume of sample}} \quad (3)$$

2.2.2 Pack/tapped bulk density

As described by Onwuka (2005), in 10 mL graduated measuring cylinder, the samples were packed by gently tapping the cylinder on the bench top 10 times from height of 5 cm. The weight of the sample was recorded.

Pack Bulk density (g mL^{-1}) =

$$\frac{\text{Weight of the sample after tapping}}{\text{Volume of sample}} \quad (4)$$

2.3 Reconstitution Index

The reconstitution index was determined by a method of (Banigo and Akpapunam, 1987; Onwuka, 2005) with a slight modification 1 g of milled hot pepper was mixed with 10 mL of boiled water and the mixture was agitated for 90 seconds. It was then poured to a graduated cylinder and the volume of the sediments was recorded after 10 minutes of settlement.

Reconstitution index (R.I (mL g^{-1})) =

$$\frac{\text{volume of sediment}}{\text{weight of sample}} \quad (5)$$

2.4 Measurement of pungency

2.4.1 Determination of Capsaicin Content

(1) Extraction

Extraction was performed using soxhlet apparatus as described by (Reddy and Sasikala, 2013; Koleva et al., 2013). The extraction was made with the same ratio 0.2g:25 mL of solid-liquid phase. In order to assure the solvent volume for solvent for the soxhlet apparatus, 1.2g of grounded pepper in 150 mL of 96% ethanol. The extraction was performed for 3 hours on temperature of 80°C -85°C since ethanol boiling point is 78°C final extract was also diluted in a ratio of 1 mL:25 mL.

(2) Method of determination and quantification of capsaicin

1 mL of the diluted extract was measured using spectrophotometer UV/VIS at 280 nm the absorbance measurement of the concentration of capsaicin in the extract was evaluated through lambert-beer's law where absorbance on wavelength = 280 is equal to the absorbance multiplied by the extinction coefficient. The absorbance is compared with the absorbance of standard solutions at different concentrations.as described by Koleva et al. (2013).The pungency level in Scoville heat units (SHU) was calculated by using the amount of capsaicin = (% dry weight) × 150,000 (Govindarajan and Sathyanarayana, 1991).

2.5 Measurement of Hot Pepper Powder colour

2.5.1 Extractable colour

The colour was determined following the (ASTA standard, 1997) procedure 0.1g of the paprika powder was weighed and placed in a 100 mL volumetric flask and the volume is made up with acetone. The mixture where left in dark at room temperature for 16 hrs. The colour extract was determined using a spectrophotometer at 460nm wavelength using the solvent as blank at 470 nm wavelength. The result was reported in ASTA units following the procedure ASTA.

$$\text{ASTA Units}=\frac{\text{absorbance at 450nm} \times 16.4}{\text{weight of sample}} \quad (6)$$

Absorbance at 450 = -$\log_{10}$ absorbance

2.5.2 Visual colour

10 g of each sample was transferred into a Petri dish and measurement was performed at three different positions. The sample surface of the dried pepper powder or the Petri dish containing the pepper powder was placed on the target mask with the sample area covering the aperture. The same procedure is repeated for visual colour only the CIElab software was used to obtain the L, a, b of colours on the colour scale as described by Addala et al. (2015).

2.6 Evaluation of sensory attributes of hot pepper

The sensory attributes of pepper were determined using seven-point hedonic scales.

A number of 18 semi trained panellist were used to evaluate the following parameters of the pepper. Colour, aroma, pungency and general acceptability respectively. Panellist were briefed on the following lexicon and how to report descriptive.

Coded samples were presented in a petri dish covered with aluminium foil to prevent any odorant to panellist to check for the above parameters using their sense organs.

Face mask were issued to members and they were asked to carry out sniffing taste for the parameters of aroma and pungency after which a piece of tissue paper was used to clear nostrils five minutes were taken before subsequent tastes as suggested by Toontom et al. (2012), Toontom et al. (2016), and Cometto-Muñiz et al. (2005).

2.7 Experimental design

A 4×2 factorial design was employed with 3 replications was used data are reported in mean and Standard deviation. For Mean separation at ($P<0.05$) significance levels LSD and DMRT for sensory parameters was employed using SPSS 21.0 software.

3 Results and Discussion

3.1 Particle size distribution

Percentage Particle size distribution of hot pepper according to aperture sizes the particle sizes showed a slight variation on all hot pepper powders. Also, Oh et al. (2013) reported a normal distribution of pepper powder over a range 0.150- 0. 600 mm with 70% of samples was retained in a sieve aperture size. At the aperture sizes of 0.425 mm and 0.210 mm has the overall particle size distribution which account for more than 50% of the particle distribution on the scale of d_{50} define powder as moderately fine (WHO, 2012).

Table 1 Hot peppers drying time and moisture content

Drying Temperature (°C)	Time (hours)	Moisture content(g H_2O/100g dry solid)
80	0	6.94
	0.5	4.78
	1	3.00
	1.5	2.18
	2	1.33
	2.5	0.58
	3	0.26
	3.5	0.19
	4	0.15
	4.5	0.11
85	0	6.94
	0.5	4.56
	1	1.96
	1.5	0.87
	2	0.31
	2.5	0.21
	3	0.18
	3.5	0.11
90	0	6.94
	0.5	4.43
	1	2.86
	1.5	1.55
	2	0.67
	2.5	0.28
	3	0.21
	3.5	0.11
95	0	6.94
	0.5	4.42
	1	1.93
	1.5	0.95
	2	0.19
	2.5	0.17
	3	0.11

3.2 Quality Attributes

Table 3 Effect of drying temperature milling time on the of quality hot pepper powder

Drying temperatures ˚C	Milling time(mins)	Bulk density (gm^{-3})		Reconstitution Index (gmL^{-1})	Pungency (SHU)
		Pack	Loose		
80	5	$0.62^{a}\pm0.0$	$0.45^{ab}\pm0.0$	$8.50^{ab}\pm0.5$	$35715^{d}\pm30.0$
	10	$0.58^{ab}\pm0.0$	$0.43^{ab}\pm0.0$	$8.00^{b}\pm1.0$	$32595^{e}\pm20.02$
85	5	$0.61^{a}\pm0.0$	$0.45^{ab}\pm0.0$	$7.00^{c}\pm1.0$	$39575^{b}\pm10.0$
	10	$0.54^{ab}\pm.0$	$0.39^{b}\pm0.0$	$8.80^{ab}\pm1.0$	$37170^{c}\pm30.0$

90	5	0.56^{ab}±0.0	0.44^{ab}±0.0	8.00^{b}±0.2	38040 ^{c}±20.0
	10	0.55^{ab}±0.1	0.49^{a}±0.1	7.50^{bc}±0.5	40745^{a}±10.0
95	5	0.52^{b}±0.7	0.45^{ab}±0.1	9.00^{a}±0.0	38865^{b}±10.0
	10	0.57^{ab}±0.0	0.43^{ab}±0.0	9.40^{a}±1.4	39685^{b}±10.0
LSD		0.1	0.1	1.2	20

Note: SHU= Scoville Heat unit.

Results are means of triplicate each, Values with uncommon superscripts are significantly different (P> 0.05).

Mean± standard deviation

3.2.1 Bulk density

Table 2: Effect of drying temperature milling times on the particle size distribution of hot pepper powder

Drying temperature (^{0}C)	Milling Time (minutes)	Particle Size Distribution (%)				
		Sieve Aperture size (mm)				
		1.40	0.425	0.210	0.150	0.090
80	5	0.35±0.26^{b}	13.31±4.49^{c}	79.87±10.12^{a}	6.45±5.88^{b}	0.02±0.02^{b}
	10	0.31±0.05^{b}	8.99±2.3$\backslash^{cd}$	76.47±10.83^{ab}	11.78±10.85^{b}	2.45±2.36^{b}
85	5	0.48±0.24^{b}	5.83±2.33^{cd}	63.96±7.57^{b}	27.95±6.76^{a}	1.77±1.75^{b}
	10	0.66±0.03^{b}	2.66±0.60^{d}	64.32±5.61^{b}	22.49±2.92^{a}	9.86±2.07^{a}
90	5	0.48±0.03^{b}	9.51±3.73^{cd}	79.68±4.99^{ab}	9.01±0.41^{b}	1.32±0.88^{b}
	10	1.34±0.11^{a}	22.71±3.31^{b}	69.77±9.19^{b}	6.13±4.17^{b}	0.06±0.06^{b}
95	5	0.69±0.12^{b}	36.51±1.66^{a}	50.25±4.26^{c}	10.16±0.22^{b}	2.38±2.27^{b}
	10	1.39±0.45^{a}	29.99±3.0^{ab}	65.62±1.72^{b}	2.99±1.76^{b}	0.02±0.01^{b}
	LSD	0.35	11.07	10.56	2.47	2.07

Note: Mean± standard deviation. Values with uncommon superscripts are significantly different (P> 0.05)

3.2.1.1 Pack bulk density

A slight variation of the pack bulk density of hot pepper powder a slight variation was observed from Table 2. The results are in conformity with the findings of Zaki et al. (2013) who reported density of 0.49-0.62. 0.43-0.45 kg m^{-3}. Also, Oh et al. (2013) reported tapped bulk density of chili at a ranges of 0.43- 0.56 kg cm^{-3} pepper to be the result showed a slight difference with LSD 0.1. There is a slight significant difference in the in the bulk density of the pepper as temperature increases the density reduces also as milling time increases. The density of the particle reduces these can be attributed to the particle size distribution and moisture contentment of the powder since pepper are hygroscopic in nature (Barbosa-Cànovas et al., 2005).

3.2.1.2 Loose bulk density

The loose bulk density of hot pepper powders as observed as drying temperature increases there is no observable increase in bulk density of the powder 0.45-0.44 gm^{-3}, as milling time increases there is a decrease in bulk densities of the powders 0.45-0.39 gm^{-3} when compared between same temperature and milling time. It can be explained that drying temperature have no effect on the density of powders which indicated that hot pepper is porous after drying. Similarly, Oh et al. (2013) reported a decrease in bulk density of chilli powder with range of 0.34-0.45 kg cm^{-3} and was in the opinion that the porosity of food which can be both internal or external or both. The loose bulk density of food powders ranges from 600-1400kg cm^{-3} which indicates Bulk density can be affected by particle size distribution, the geometry of the powder. Powders depends on the inter-relative factors such as intensity of attractive inter-particle forces, particle sizes and number of contact point also moisture content (Barbosa-Cànovas et al., 2005).

3.3 Reconstitution index

The relationship between reconstitution index of hot pepper and milling as observed increase in drying temperature increases the reconstitution index of the powder also as milling time increases reconstitution increases for powder dried at 85°C and 95°C and decreases for powder dried at 80°C and 90°C. This can be explained higher temperature of drying increases the absorption of powder due to structural break, the finer the particle size of the powder the higher the absorption capacity. This is in conformity with the findings of

Oluwamukomi and Adeyemi (2015) reported a significant difference in the reconstitution index of yam Pando flour range from 5.97-6.76 v/v, also Famurewa and Faboya (2017) reported higher water absorption of food powders, better used as thickener. According to Igyor et al. (2011) who reported that reconstitution index is particle size and temperature dependent.

3.4 Colour

Table 4 Effect of drying temperature and milling times of hot pepper powder on the colour

Drying temperature (^{0}C)	Milling Times (Minutes)	Extractable colour (ASTA value)	Visual colour L*	a*	b*
80	5	2491.27^d±4.9	22.12^a±1.5	18.30^d±0.3	21.53^d±1.0
	10	2594.90^a±1.6	19.35^{ab}±6.7	17.45^d±3.0	32.94^c±7.3
85	5	2528.27^c±1.4	22.88^a±2.6	36.80^a±4.0	61.36^a±3.5
	10	2433.23^f±2.5	14.02^b±3.9	24.45^b±1.9	48.10^b±6.0
90	5	2357.83^g±2.0	13.56^b±1.2	29.96^b±1.2	47.58^b±2.0
	10	2329.80^h±4.7	22.67^a±1.2	32.12^b±2.7	24.23^d±2.0
95	5	2485.80^e±0.0	23.14^a±2.5	23.95^c±0.1	24.82^d±3.9
	10	2581.43^b±3.1	23.43^a±2.3	20.70^{cd}±1.0	23.93^d±5.8
	LSD	4.2	4.6	3.1	6.4

Note: ASTA Value= American spice trade association value, L* measure for brightness, a*= measure for redness, b*= measure for yellowness

Mean± standard deviation

Results are means of triplicate each, Values with uncommon superscripts are significantly different (P> 0.05).

3.4.1 Extractable colour

The extractable colour of hot pepper powder signified that there was significant effect of drying temperature and milling time on the hot pepper. The least ASTA unit was recorded from 90°C: 10 mins (2329.80±4.73) ASTA unit. These results are in line with ASTA specification (1997) where they reported that ASTA value above 2000 ASTA unit was accepted for all pepper powders. It was shown that there was significant difference at LSD 4.2, which showed that there was a prominent effect of drying temperature and milling time as it affects the colour, it which was reported that when pepper was dried at high temperature and it affects the volatile compound and when the water activity is below 4% bleaching occurs (Krajayklang et al., 2000). Dehydration process at 95°C affects the retention of colour which results in the degradation of carotenoids and other antioxidants milling too affects the retention as a result in temperature build-up as reported for Tepić and Vujičić (2004) that the degradation of carotenoid is as a result to exposure to heat, oxygen and light, drying affects, the colour content of paprika. Naturally convective dried paprika samples have retained more carotenoid pigments than the samples subjected to hot air oven, refractive window and freeze drying (Topuz et al., 2011; Topuz et al., 2009).

3.4.2 Visual /Surface Colour

The L* which is the measure of brightness which is similar to the findings of Zaki et al., (2013) who reported the L* value ranges from 23-29 depending on the morphotype, also, Chaethong et al. (2012) reported a similar range of 22- 27 for treated pepper. Statistically LSD 4.60 showed that there was significant effect of drying temperature and milling times on the Hot pepper in terms of brightness.

The a* is the measure of redness of hot pepper similar results were reported by Chaethong et al. (2012) and Zaki et al. (2013) with the range for pretreated pepper range from 18- 22 and 25- 36 based on morphotypes. Statistically LSD 3.11 it results showed a wide range of difference in the redness of the samples these could be attributed to the effect of heat and the use of hot air oven as it affects the carotenoids content of pepper (Tepić and Vujičić, 2004) or the drying instrument used for the drying as hot air oven affects the colour of paparika drying (Topuz et al., 2011; Topuz et al., 2009). Also milling affects, the colour of paprika (Mallappa et al., 2015).

The b* value is the measurement of yellowness of hot pepper powder (Chaethong et al., 2012) who reported a range of 9-12 and a slightly lower than the report of 42-50 by Zaki et al. (2013) and ranges from 21-61 result are slightly higher than the pretreated pepper reported by

Zaki et al., (2013). There is a significant difference in the yellowness at LSD 6.4 based on morphotypes. The measure of higher yellowness of paprika is appreciated as reported by ASTA (1997). The samples showed a wide range of variation, and these could be attributed due to the colour change of red pepper powder was greatly dependent on temperature and water activity and that as temperature and water activity increased, red colour of pepper powder increasingly faded out to become brown and tarnish black, which is mainly attributed to the degradation of carotenoid pigments and development of browning compounds (Osuna-Garcia and Wall, 1998).

3.5 Pungency

The capsaicinoids content of the hot pepper are classified as highly pungent using the scoville scale which is in the range of 25000- 70000 SHU. Nwokem, et al. (2010) reported a higher value of Miango pepper 114.744 SHU for fresh pepper variation of pungency might be due to the interference with β-carotenoids, drying temperatures, time of harvest and milling (Koleva et al., 2013). Increase in capsaicin content of dried pepper as a result in increase in temperature of drying is also reported by Topuz and Ozdemir (2004) that treating chilli at temperature 210 ^{O}C increases the capsaicin content from 6.1%-92.4%. This was caused by the dehydration of the food matrix and improved extractability of capsaicin by cell in chilli pepper (Toontom et al., 2012). From Table 3 it can be observed that there was no effect of the processing on the powder. This is attributed to the increase in temperature and pressure generated during drying and milling of the powder which result to the loss of volatile compounds. (Bankole et al., 2013). LSD 0.00 showed no effect of temperature on the pungency of hot pepper.

3.6 Sensory attribute

Table 5 Effect of drying temperature and milling time of hot pepper powder on sensory attributes

Drying temperature (^{0}C)	Milling Time (minutes)	Color	Aroma	Pungency	General acceptability
80	5	5.67±1.03^{abc}	5.5±1.23^{ab}	6.0±1.67^{a}	6.0±0.63^{ab}
	10	5.33±0.52^{abc}	5.5±0.55^{ab}	5.5±0.84^{a}	5.83±0.41^{ab}
85	5	6.17±0.41^{ab}	6.0±2.00^{ab}	5.33±1.51^{a}	5.5±1.23^{b}
	10	5.67±0.52^{abc}	6.17±0.41^{ab}	7.00±0.00^{a}	5.83±0.41^{ab}
90	5	7.00±0.00^{a}	7.00±0.00^{a}	6.33±0.52^{a}	7.00±0.00^{a}
	10	6.00±1.67^{ab}	5.00±1.27^{bc}	5.67±1.86^{a}	6.17±2.04^{b}
95	5	4.33±2.07^{cd}	2.67±1.21^{d}	6.17±2.04^{a}	5.00±1.27^{cb}
	10	3.17±1.47^{d}	3.83±1.84^{cd}	6.33±1.03^{a}	3.83±0.98^{c}

Note: Result is a mean of 18 panellist response on a scale with 7= excellent and 1= very poor

Values with uncommon superscripts are significantly different ($P > 0.05$)

3.6.1 Visual appearance

The appearance of hot pepper powder as observed in Table 5 there was a significant difference which indicates that drying and milling has effects on the colour. Hot pepper dried at 90°C and milled at 5 minutes is most preferred (7.0000) followed by samples dried at 85°C then 80°C and 95°C which showed that the samples where dark in colour the effect of change in colour is as a result of Millard reaction and temperature the change in colour for 80^{o}C is as a result of time taking for samples to start drying and also in 95°C the high temperature build up (Magied et al., 2014). Naturally convective dried paprika samples have retained more carotenoid pigments than the samples subjected to hot air oven, refractive window and freeze drying (Topuz et al., 2011; Topuz et al., 2009). Comparing with the ASTA unit from Table 4 and Table 5 it can be observed that there is disagreement between the sensory and chemical test where the extractable colour reported sample dried at 95^{o}C:10mins also from the apparent or surface colour the sample dried at 85^{o}C and milled at 5 minutes is said to be more stable.

3.6.2 Aroma

Effect of processing (drying temperature and milling time) for hot pepper powder was observed in Table 5 subjectively using the seven hedonic point scale. pepper dried at 90^{o}C and milled at 5 minutes is most preferred. Samples dried at 95^{o}C which was mostly rejected due to the likeness of burnt aroma which was detected. It can be explained from the point of Maillard reaction which is partly as a result of high temperature build up during drying and milling (Apriyantono and Ames, 1993). Bankole et al. (2013) was at the opinion that the increase in temperature and pressure generated during drying and milling of the powder which resulted to the loss of volatile compounds.

3.6.3 pungency

Processing methods do not affect the pungency of hot pepper. The results obtained from seven-point hedonic scale showed that all hot pepper powder is highly pungent. This is in conformity with findings of Toontom et al. (2012, 2010, 2016). Who reported that there is no effect of processing method on the pungency content of chilies. Milling and drying has no significant effect on the pungency of the samples this was also observed by Toontom et al. (2016). Although subjective analysis will not give a true picture of the pungency of pepper that is why it is replaced by chemical test. Comparing with the chemical test for pungency from Table 4 which showed effect of processing on the pungency of hot pepper powder.

4 Conclusion

Drying temperatures and milling times affect the quality of hot pepper powder. the best drying temperature and milling time was observed at 90°C: 5 and 10 minutes for particle size distribution product 85°C: 10 minutes show the finest particle, the pungency was highest at product dried and milled at 90 °C: 10 minutes while product with the highest ASTA units was 80°C: 10 mitues which indicates that such product will have a higher money value and will store longer. Product according to the visual colour showed that 85°C:5 minutes will have the highest keeping quality since the yellowness is higher in it.

Drying temperatures and milling times affect the general acceptability of hot pepper powder. Product dried and milled at 90°C: 5 minutes tends to be more acceptable subjectively.

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