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Quality characteristics of stored varieties of tiger nut oil

Akama Friday Ogori1*, G. C. Nina2, and M. Ukeyima2

1Department of Home Sciences, Faculty of Agriculture, Federal University, Gashua, P.M.B.1005 Gashua, Yobe State, Nigeria
2College of Food and Human Ecology, Department of Food Science and Technology, Federal University of Agriculture, Makurdi, Benue State, Nigeria.

Abstract
Quality characteristic of stored tiger nut oil was studied. Different tiger nut cultivars were sourced and their oil extracted using hexane. Oil were stored in plastic bottles for 12 weeks at room temperature revealed moisture content of 0.39%, 0.48%, and 0.30% for black, brown and yellow varieties respectively. Thiobarbituric acid value of stored tiger nut oil were 0.49 malondialdehyde/mg black tiger nut oil, 0.51 malondialdehyde/mg yellow, and 0.35 malondialdehyde/mg for brown cultivars respectively. The free fatty acids (FFAs) of the tiger nut oil ranged between 0.75%-0.87%, 0.38%-0.41% and 0.20%-0.21% for varieties respectively. The black tigernut oil and the brown tiger nut oil FFAs increased during oil storage. Peroxide values decrease between 5.76-5.50 meq/kg, 5.65-5.68 meq/kg and 4.36-4.32 meq/kg for varietal cultivars respectively. During storage periods tiger nut oil from varied sources confers oil stability. The properties measured revealed food grad and commercial use of varietal tiger nut oils because they are within limits as marked by standard.

Keywords: oil, plantain chips, shelf stability, sensory, quality

Introduction

Cyperus esculentum is a perennial grass-like plant with spheroid tubers, pale yellow they are edible, sweet, nutty, flavoured tubers which contain adequate nutrients (Nina et al., 2020). According to Nina et al. (2019), modifying tiger nut via various processing techniques for sensorial acceptability has been opined. According to Nina et al. (2020), three varieties of tiger nuts namely: black, brown and yellow. Only yellow and brown could be readily found. However yellow cultivar is preferred for its yields of milk and functional bioactive components properties (Okafor et al., 2003). According to Nina et al. (2020), oil obtained from tiger tuber has better quality. Tiger nut oil could remain in a uniform liquid form at refrigeration temperature, and therefore has been opined suitable for food applications due to its high oleic acid and low polyunsaturated fatty acid (linoleic acid and linolenic acid) contents (Ezebor et al., 2005; Nina et al., 2020). The presence of polyunsaturated fatty acids and gamma-tocopherol contents in tiger nut stabilizes its oxidative tendencies. It is a quality oil and recommended for cooking compared to other oils because it resistant to chemical agent decomposition even at high temperatures (Nina et al., 2020; Shaker et al., 2009). However could be altered by visceral enzymes either in-vivo or in-vitro.

The importance of vegetable oils is increasing even as source of health enhancing compounds in which tiger nut oil has become one Nina et al. (2020). However oil stay are generally affected by chemical, physical and intrinsic agent against their shelf stay. This work seeks to investigate the quality of tiger nut oil when stored for future applications.

Materials and Methods

Raw materials
Brown, black and yellow tiger nuts were bought from open North bank market Makurdi, Benue State, Nigeria and identifications made at Department of Agronomy, Federal University of Agriculture, Makurdi (Fig. 1).

Tiger nut oil processing
Normal n-hexane, a non-polar solvent according to AOAC International (2012) method was used to extract tiger nut oil from the resulting flour. Flour samples (105.0 g sample A,
105.0 g for sample B and 105.0 g for sample C) were used for tiger nut oil extraction using soxhlet extractor (Fig. 2; Adejuyitan, 2011). The lipid was extracted for 5 h. with a 500 mL volumetric flask containing the solvent, which was heated with an electric heater at 70°C. Solvent extracts were evaporated off using rotary evaporator and later oil was oven dried at 105°C for 1 h and stored in bottles to be analysis (Fig. 3).

Determination of moisture value

Moisture content was determined by the AOAC Official Method (AOAC International, 2010). Dried and weighed moisture dishes were added 5 g of tiger nut oil respectively. This was heated in an oven Memmert at 105°C for 1 h, then cooled in a desiccator containing phosphorus peroxide and then weighed. This was repeated until a constant weight was obtained.

\[
\% \text{Moisture} = \frac{\text{Loss in mass on drying}}{\text{Weight of test sample}} \times 100
\]

\[
\text{Ms} - \text{Mh}
\]

\[
\text{Ms} = \text{weight of moisture dish+sample}
\]

\[
\text{Mh} = \text{weight of moisture dish+sample after heating}
\]

\[
\text{Mt} = \text{weight of tare/moisture dish}
\]

Thiobarbituric acid value

The method described by Benchamaporn et al. (2009) was used. Fifty milligram oil sample was accurately weighed into a twenty-five milliliter volumetric flask and dissolved in a small volume of 1-butanol and made up to volume with 1-butanol. 0.5 mL of the oil sample was transferred to a dry test tube and 5 mL of thiobarbituric acid (TBA) reagent solution (0.2883G/100 ml of 90% glacial acetic acid) added. The test tube was closed with a ground-glass stopper, mixed thoroughly
and placed in a thermostatic bath at 95°C. After 120 min, the tube was removed from the thermostatic bath and cooled under running tap water for 10 min until it reaches room temperature. The absorbance of the reaction solution was measured at 530 nm using distilled water in the reference cuvette. A blank was also prepared and read. The result was calculated using the equation below:

\[
\text{TBAR value} = \frac{[50-(A-B)]}{M}
\]

\[A=\text{absorbance of the test solution}\]

\[B=\text{absorbance of the reagent blank}\]

\[m=\text{the weight (g) of the test sample}\]

**Peroxide value**

The AOAC (2012) method was adopted. Oil sample (2.0 g) was accurately weighed into a conical flask, and dissolved in a solvent mixture containing 12 mL chloroform and 18 ml glacial acetic acid. To the solution 0.5 ml of a saturated aqueous potassium iodide solution were added. The flask was stoppered and allowed to stand for 1 min. Thirty milliliters of water were added and the solution was titrated with 0.1 M sodium thiosulphate solution until the yellow colour gone. Starch solution (0.5 mL) was introduced and titration continued with the reagent added slowly until the blue-black colour disappeared. During titration, the flask was continuously and vigorously shaken to transfer the liberated iodine from the chloroform layer to the aqueous layer. A blank titration was also performed, and the peroxide value was obtained from the formula (Sadoudi and Ali, 2017):

\[
\text{PV (meqO}_2 / \text{Kg oil}) = \frac{[(V - V_b)\times N]}{m} \times 10^3
\]

\[\text{PV=peroxide value}\]

\[V=\text{volume of Na}_2\text{S}_2\text{O}_3 \text{ solution used for the sample test}\]

\[V_b=\text{volume of Na}_2\text{S}_2\text{O}_3 \text{ solution used for the blank test}\]

\[N=\text{normality of Na}_2\text{S}_2\text{O}_3 \text{ solution}\]

\[m=\text{weight of the oil sample taken}\]

**Free fatty acid (FFA) content**

Into dry beaker was measured 2 g of pre-heated oil to 50°C and re-measured. Aliquots of ethanol were added to the oil to completely free the fatty acids. The ethanol-oil mixture was then titrated with 0.1N NaOH using phenolphthalein indicator. The volume (V) of NaOH required to produce the first permanent pink colour was recorded to evaluate free fatty acid (FFA) content of the oil from the formula (AOAC International, 2012).

\[
\text{Free fatty acid (FFA)%} = \frac{\text{M×V×N}}{10×m}
\]

\[\text{M=relative molecular mass of palmitic acid=256}\]

\[\text{V=volume of NaOH used}\]

\[\text{N=Normality (concentration) of NaOH}\]

\[m=\text{weight of oil used}\]

\[10=\text{constant}\]

**Storage studies**

The tiger nut oil was packaged and stored in bottles at room temperature (28°C) for a period of three months (12 weeks) away from visible ray of light. The samples were taken analysed at two weeks interval to evaluate FFA, thiobarbituric acid and moisture content.

**Statistical analysis**

Experiment was conducted in duplicate and subjected to analysis of variance (ANOVA) using statistical package of Social Sciences (SPSS) version 20.0. The means separation was done using Duncan multiple range test and significant difference was established at \(p<0.05\).

**Results and Discussion**

**Effect of storage on the moisture content of tiger nut oil**

Storage time increased but the moisture content increased and decreased slightly as the storage time increased significantly at \(p<0.05\); Fig. 4). It was also in agreement with the acceptable limit for moisture content of oils. The moisture content of food however gives an indication of its shelf-stay and nutritive value, hence low moisture content is a requirement for long storage life (Okene and Evbuomwan, 2014).

**Effect of storage on free fatty acid of tiger nut**

Effect of storage on FFA of tiger nut oil is shown in Fig. 5. FFA values of the stored oil for sample of oil from black tiger nut from 0 to 12 weeks were ranged between 0.75-0.87, sample Brown (0.39-0.41) while sample yellow ranged from 0.19-0.22. The FFA values for sample black and brown increased during storage while in sample Yellow; there was an
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5.
Concentration
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of
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tiger
nut
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stored
black
tiger
nut
oil;
□,
stored
brown
tiger
nut
oil;
△,
stored
yellow
tiger
nut
oil.
Values
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of
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different
superscripts
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significantly
different
(p<0.05).
unsteady
decrease
in
FFA
during
storage.
Effect
of
storage
on
the
thiobarbituric
acid
of
tiger
nut
oil
This
procedure
measures
the
malondialdehydes
(MDA)
formed
as
the
split
product
of
an
endo
peroxide
of
unsaturated
fatty
acids
resulting
from
oxidation
of
a
lipid
substrate
(Antolovich
et
al.,
2002).
Brown
tiger
nut
oil
seem
stable
from
the
graph.
The
black
was
stable
for
TBA
but
start
decreasing
with
time.
The
yellow
sample
was
unstable.
These
variation
may
be
due
to
varieties
of
samples
sources
and
ability
to
absorb
transmit
or
deflect
light.

Measures
in
secondary
lipid
oxidation
products
changes
of
the
oils
during
storage
for
a
period
of
3
months
are
shown
in
Fig.
6.
Significant
(p<0.05)
difference
existed
between
black
and
brown
and
as
storage
time
increased
only
for
yellow,
there
was
changes
in
the
TBA
values
as
the
storage
time
increased.
It
seems
that
the
increase
and
decrease
of
TBA
value
were
as
a
function
of
time
of
heating
depends
on
the
number
of
malondialdehydes
produced.
This
result
values
collaborated
with
Gulla
and
Waghray
(2011)
work
that
reported
storage
studies
on
sesame
and
rice
bran
oil,
TBA
measures
secondary
lipid
oxidation
products,
which
are
also
responsible
for
the
rancid
taste
during
storage
(Decker
et
al.,
2000).
Storage
effect
on
the
peroxide
value
of
tiger
nut
oil
Storage
time
increased
but
the
peroxide
value
decreased
as
the
storage
time
increased.
Fig.
7.
The
graph
indicate
a
stable
peroxidicity
of
the
oil
samples,
implying
that
the
oil
could
be
readily
stable
under
favourable
state.
The
Perioxide
value
of
an
oil
or
fat
is
used
as
a
measurement
of
the
extent
to
which
oxidation
reactions
have
occurred
during
processing
and
storage.
Autoxidation
in
this
oil
are
relatively
stable,
involving
less
oxygen
that
could
leads
to
deterioration
of
fats
and
oils
which
could
have
form
off-flavors
and
off-odors.
The
values
obtained
during
storage
did
not
exceed
the
limit
of
10
meq/kg
(SON,
2000).
According
to
Alhibshi
et
al.
(2016)
these
varietal
sample
oil
are
safe.
Perioxide
values
of
this
oils
are
less
than
10
milliequivalents
/kg
Rancidity
set
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at
peroxide
value
between
30
and
40
milliequivalents/kg.,
However,
high
peroxide
values

Fig.
6.
Concentration
of
TBA
of
stored
oil
from
different
varieties
of
tiger
nut.
key:
◇,
stored
black
tiger
nut
oil;
□,
stored
brown
tiger
nut
oil;
△,
stored
yellow
tiger
nut
oil.
Values
are
Means±SD
of
triplicate
determinations.
Means
values
down
the
column
followed
with
different
superscripts
are
significantly
different
(p<0.05).
TBA,
thiobarbituric
acid.
are a definite indication of rancid fat, but moderate values may be the result of depletion of peroxides after reaching high concentrations (Kamsiah and Yusof, 2012).

Conclusion
Quality parameters of stored tiger nut oil showed that there was change during storage but the changes in FFAs, peroxide values, thiobarbituric acid values for all varietal samples are with recommended limits by standard hence food and home application plausible. The properties of the stored tiger nut oil for the 12 weeks showed that the oil is could be useful and can play important roles in providing food security. Because the sources are relatively cheap and abundant, these could enhance livelihoods, improve nutritional status and social wellbeing for vulnerable groups.

Conflicts of Interest
The authors declare no potential conflict of interest.

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Ethics Approval
This article does not require IRB/IACUC approval because there are no human and animal participants.

Author Contributions
Conceptualization: ogori AF, Ukeyima M.
Data curation: Ogori AF, Nina C.
Formal analysis: Nina C, Ukeyima M.
Methodology: Ogori AF, Nina C.
Software: Nina C.
Validation: Ukeyima M.
Investigation: Nina C.
Writing-original draft: ogori AF, Nina C.
Writing-review and editing: Ogori AF, Nina C, Ukeyima M.

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