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Mycological & Physico-Chemical Quality of Wheaten White Bread Flour Made for Nigerian Market

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Mycological & Physico-Chemical Quality of Wheaten White Bread Flour Made for Nigerian Market

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Keywords : Mycological, physico-chemical, wheaten, flour, bread

I. Introduction

Wheaten white bread flour consists mainly of ground endosperm of the wheat (*Triticum* species) kernel (Badshah *et al.,* 2005). There are several commercial grade of wheat flour and, the flour is made from different blends of wheat. The composition of the flour is therefore variable and the quality of the flour may differ according to geographical region, milling process, and the quality of the wheat (Quaglia, 1984).

Physico-chemical properties such as fat, carbohydrate, protein, moisture, ash, gluten and pH are of technological and nutritional importance. The proportion of these factors in the flour depends on the variety of wheat grain used and also depends on the standards recommended by the particular country's industrial standards (Adeyemi, 2003; Badshah *et al.,* 2005).

The standards for wheat flour (white flour) as recommended by Standards Organization of Nigeria (SON) and International Standards required that the flour be free from rancidity, objective odour, insects, rodents' hair and any other extraneous material (SON, 2000).

The quality of flour and storage condition after milling is very important in the shelf life of the flour. Studies have revealed that gradual changes of physico-chemical properties occur in the flour during storage (Kent-Jones and Amos, 1967; Sur *et al.,* 1993; Hruskova and Machova, 2002).

Mould growth has a detrimental effect on the quality of flour (Weidenborner *et al.,* 2000). A number of mould and yeast have been isolated from wheat flour and these fungi are responsible for the enzymatic activity in the flour. In a study in Germany, it was discovered that the overall degree of mould and mycotoxin contamination was lowered with decreasing ash content (Schollenberger *et al.,* 2002). This suggests a localization of the fungi primarily in the outer part of the wheat kernels. The recommendation for total mould count in Nigerian flour is 100 per gram of flour (SON, 2000).

There is very little or no information on the Mycological and Physico – chemical quality of flour in the Nigeria market. This survey is intended to augment the scarce information on the Mycogical and Physico – chemical quality of Nigeria flour.

II. Materials and Methods

a) Sample Collection

Freshly milled wheaten white flours ready for packaging were collected from four mills located at Lagos, Sapele, Ewu and Kano, all in Nigeria. Two samples were collected from each location in clean polythene bags and properly sealed. The samples were kept in the laboratory at room temperature and observed for bacteriological and physico – chemical changes. Samples were aseptically opened and analysed at 15 days intervals for a period of 4 months; this period was based on the assumed shelf – life of 3 – 4 months of the flour by the millers.

b) Mycological Analysis

The various types and numbers of mould and yeast associated with wheaten white bread flour were enumerated and quantified according to the method described by Harrigan and McCane (1976). Isolation of fungi was carried out using potato dextrose agar (PDA) (LABM) supplemented with chloramphenicol to inhibit

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bacterial growth. The media were incubated at 35°C for 72 hours. Total fungi were estimated as colony forming units per gram (cfu/g) of *flour.*

c) Characterization And Identification of Isolates

The fungi isolates were identified based on the examination of the conidial heads, phialides, conidiophores and presence or absence of foot cell or rhizoids (Samson and Reemon-Hoekstra, 1888). Wet preparations of actively growing fungi were placed on a glass slide with a methylene blue stain, covered with a cover slip and observed with X40 objective under the microscope.

d) Determination Of Physico – Chemical Properties of Flour

i. *pH*

A pH meter (JENWAY 3310) was used to determine the pH of 10% suspension of flour in water after standardizing with buffer at pH 7. A standard buffer 7 powder was prepared into 200ml solutions with distil and ionise in a volumetric flask. The buffer solution was poured into a beaker and the pH electrodes immersed in and regulated to stabilize at pH 7. There after, the electrodes were removed and introduced into the filtrate from the 10% flour suspension and allowed to stabilize and the final pH reading to be taken.

ii. *Moisture*

Moisture content was determined using the dry oven method (Polemeranz and Meloan, 1996).

iii. *Gluten*

Extraction of gluten was done according to the ICC (international cereal chemistry)– Standards No 106/1.

iv. *Protein*

Analysis of protein content was done using the Kjeldahl method. The sample was heated in sulphuric acid and digested until the carbon and hydrogen are oxidized and the protein nitrogen is reduced and transformed into ammonium sulphate. The concentrated sodium hydroxide is added and the digest heated (distillate) to drive off the liberated ammonia into a known volume of standard acid solution. The unreacted acid is determined and the results are transformed by calculation with factor 5.7 into a percentage of protein in the flour sample.

v. *Carbohydrate*

This was estimated according to the ICC – standard No. 123, method for the determination of starch content by hydrochloric acid dissolution.

vi. *Fat*

Extraction of fat was performed by the Soxtec method in automatic fat extraction unit using diethyl ether.

vii. *Ash*

Determination of flour ash was carried out according to the ICC – standards No. 104, for the determination of flour ash at 900°C. The difference in weight was used to estimate the crude ash; based on the moisture content of the flour, the ash on dry matter of the flour was calculated.

e) Statistical Analysis

Changes in bacteriological and physico – chemical qualities due to duration of storage for the different brands were analysed for statistical significance using the chi – square goodness of fit. Differences in the above qualities among the different flour brands were tested for statistical significance using the Single Factor Analysis of variance (ANOVA). Where significant differences were detected, the Duncan's Multiple Range (DMR) test was used to separate means on the basis of significance. All statistical tests were carried out using the ''SPSS10.0 package''.

f) Results

Average fungi counts for the brands of flour ranges from 3.357×10^3 cfu/g (Brand 4) to 10.144×10^3 cfu/g (Brand 1) (Table 10). Significant difference ($P = 3.153$) was recorded in fungi count flour brands. During storage, significant difference ($x^2 = 55.988$) was recorded for fungi count only in flour Brand 1, with day 0 having 27.65×10^3 cfu/g total fungal counts. Brands 2, 3 and 4 show no significant difference in fungal counts during storage (table 1). One yeast and five moulds were isolated (Table 2). The difference in the moisture content of the individual brands of flour is highly significant ($P = 21.966$) but there is no significant difference in moisture content of flour during storage. There was no significant difference ($P = 0.479$) in pH of individual flour. The pH ranges from 6.03 (brand 1) to 6.12 (brand 3) (table 10). Protein and gluten content of the individual flour shows highly significant difference ($P = 18.517$). Protein and gluten for brand 2 is 11.47% and 10.23% and for brand 4 is 10.24 and 8.64 respectively. Gluten content correlates with the protein content. Carbohydrate content was between 65 – 66% in all the brands of flour with no significant difference ($P = 0.248$). Ash content increases for the individual brands of flour during storage, but statistically, there is no significant difference (table 8).

However, there is a high significant difference ($P = 7.297$) in the ash of the different brands of flour with the range of 0.56% (brand 1) to 0.80%

(Brand 4) (Table 10). Fat content of the different brand of flour ranges from 0.92% (brand 3) to 0.98% (brand 4), no significant difference ($P = 0.915$) in the fat content of the various flour brands.

Table 1 : Total Fungal Count (Cfu/G X 10^3) Wheaten White Bread Flour During Storage

FLOUR BRANDS	STORAGE PERIODS								
	DAY 0	DAY 15	DAY 30	DAY 45	DAY 60	DAY 75	DAY 90	DAY 105	Significant
1	27.65 ± 0.0	4.5 ± 0.5	1.0 ± 0.0	3.0 ± 0.0	4.0 ± 0.0	13.5 ±0.5	13.5 ± 0.0	14.0 ± 0.0	P < 0.001
2	10.0 ± 0.0	7.5 ± 0.5	NO GROWTH	3.0 ± 0.0	6.5 ± 0.5	1.0 ± 0.0	2.0 ± 0.0	6.0 ± 0.0	P > 0.05
3	1.0 ± 0.0	9.0 ± 1.0	4.0 ± 0.0	3.5 ±0.5	3.5 ± 0.5	1.5 ± 0.5	2.5 ± 0.5	3.0 ± 1.0	P > 0.05
4	NO GROWTH	1.5 ± 0.5	3.0 ± 0.5	4.5 ± 0.5	4.5 ± 0.5	2.0 ± 0.0	1.5 ± 0.5	6.5 ± 0.5	P > 0.05

NOTE : P > 0.05 = not significantly different
P < 0.001 = highly significantly different

Table 2 : Fungi Associated With Whiten White Bread Flour During Storage

FUNGAL GROUP	DAY 0	DAY 15	DAY 30	DAY 45	DAY 60	DAY 75	DAY 90	DAY 105
	BRANDS 1 2 3 4	BRANDS 1 2 3 4	BRANDS 1 2 3 4	BRANDS 1 2 3 4	BRANDS 1 2 3 4	BRANDS 1 2 3 4	BRANDS 1 2 3 4	BRANDS 1 2 3 4
Penicillium	+ ± ± ±	+ + + +	+ - ± ±	+ + + +	+ ± ±+	+ - - -	+ ± + +	+ + + +
Rhizopus	- - - -	- - - -	- - - -	- ± - -	± + ± -	- - - -	- ± + -	± + + ±
Mucor	- - - -	- - - -	- - - -	- - ± ±	- - - -	- - ± -	- - - -	- - - -
Odium	- - - -	- - - -	- - - -	- - - -	+ + - -	± + ± ±	- - - -	+ + - ±
Geotrichum	- - - -	- - - -	- ± ± +	- - - -	- - - -	- + - -	± ± - +	± + - ±
Saccharomyces	- - - -	- + - -	+ ± ± ±	+ - - -	- ± ± -	± - - -	- - ± -	- - -

+ = Present
± = Relatively present
- = Absent

Table 3 : Changes in Moisture Content (%) of Wheaten White Bread Flour During Storage

FLOUR BRANDS	MOISTURE CONTENT (%) AT								
	DAY 0	DAY 15	DAY 30	DAY 45	DAY 60	DAY 75	DAY 90	DAY 105	significant
1	12.92±0.02	12.85±0.01	12.48±0.37	12.26±0.06	12.92±0.05	13.03 ±0.00	13.16 ±0.06	12.97± 0.16	P > 0.05
2	13.00±0.06	12.67±0.04	12.53± 0.19	12.15± 0.01	12.79±0.02	12.98 ±0.09	13.00 ±0.01	13.00±0.01	P > 0.05
3	11.93±0.08	11.89±0.31	11.25± 0.05	11.60±0.44	12.02±0.05	12.27 ± 0.40	11.91±0.10	11.92±0.08	P > 0.05
4	13.65±0.08	13.23±0.01	13.19±0.01	13.22±0.02	13.71±0.03	13.82 ±0.13	13.80 ±0.07	13.85±0.00	P > 0.05

NOTE : P > 0.05 = not significantly different

Table 4 : Changes in Ph of Wheaten White Bread Flour During Storage

FLOUR BRANDS	pH OF FLOUR AT								
	DAY 0	DAY 15	DAY 30	DAY 45	DAY 60	DAY 75	DAY 90	DAY 105	significant
1	6.45±0.02	6.00±0.00	6.01 ±0.00	6.10 ± 0.05	5.76 ± 0.03	6.07 ± 0.15	6.20 ±0.01	5.64 ± 0.02	P > 0.05
2	6.20±0.01	6.01±0.01	6.01 ±0.01	6.14 ± 0.01	5.94 ± 0.01	6.14 ±0.04	6.18 ±0.01	5.77 ± 0.01	P > 0.05
3	6.21±0.01	6.03±0.01	6.0 ± 0.00	6.04 ±0.06	6.11 ± 0.01	6.21 ± 0.04	6.27 ±0.01	6.05 ± 0.03	P > 0.05
4	6.05±0.02	6.00±0.00	5.95 ±0.00	6.13± 0.01	6.09 ± 0.03	6.14 ±0.03	6.14 ±0.02	5.89 ± 0.08	P > 0.05

NOTE : P > 0.05 = not significantly different

Table 5 : Changes in Carbohydrate Content (%) of Wheaten White Bread Flour During Storage

FLOUR BRANDS	CARBOHYDRATE CONTENT (%) AT								
	DAY 0	DAY 15	DAY 30	DAY 45	DAY 60	DAY 75	DAY 90	DAY 105	significant
1	66.64 ±0.04	68.97 ±0.00	68.42 ±0.55	65.13 ±0.00	66.51 ±0.28	60.78 ± 2.21	62.65 ±0.15	64.33 ±0.03	P > 0.05
2	66.65 ±0.00	66.57 ±0.28	68.15 ±0.28	64.46 ±0.13	65.60 ±0.37	63.22 ±0.27	62.75 ±0.05	66.35 ±0.03	P > 0.05
3	60.40 ±0.20	67.97 ±0.10	68.15 ±0.28	65.78 ±0.10	69.20 ±0.27	62.95 ±0.55	63.75 ±0.25	68.70 ±0.20	P > 0.05
4	64.22 ±0.20	68.15 ±0.83	68.97 ±0.37	66.69 ±0.09	65.60 ±0.09	65.96 ±1.92	64.40 ± 0.20	66.30 ±0.10	P > 0.05

NOTE : P > 0.05 = not significantly different

Table 6 : Changes in Protein Content (%) of Wheaten White Bread Flour During Storage

FLOUR BRANDS	PROTEIN CONTENT (%) AT								
	DAY 0	DAY 15	DAY 30	DAY 45	DAY 60	DAY 75	DAY 90	DAY 105	significant
1	11.65 ±0.04	11.27 ± 0.03	11.55 ± 0.00	11.45 ± 0.05	11.49 ± 0.02	11.46 ± 0.06	11.44 ± 0.05	11.38 ± 0.02	P > 0.05
2	11.35 ±0.00	11.60 ± 0.07	11.64 ± 0.05	11.45 ± 0.03	11.45 ± 0.05	11.50 ± 0.02	11.34 ± 0.04	11.45 ± 0.05	P > 0.05
3	11.10 ±0.05	11.24 ± 0.13	11.41 ± 0.06	11.48 ± 0.08	11.18 ± 0.02	11.21 ± 0.01	10.98 ± 0.01	11.03 ± 0.02	P > 0.05
4	9.93 ± 0.08	10.09 ± 0.01	10.36 ± 0.01	10.12± 0.07	9.96 ± 0.04	10.02 ± 0.02	9.96 ± 0.02	9.85 ± 0.05	P > 0.05

NOTE : P > 0.05 = not significantly different

Table 7 : Changes in Gluten Content of Wheaten White Bread Flour During Storage

FLOUR BRANDS	GLUTEN CONTENT (%) AT								
	DAY 0	DAY 15	DAY 30	DAY 45	DAY 60	DAY 75	DAY 90	DAY 105	significant
1	10.40 ±0.00	9.96 ±0.05	10.00 ± 0.00	9.75 ± 0.15	9.68 ± 0.16	10.02 ±0.02	10.00 ± 0.00	9.90 ± 0.01	P > 0.05
2	10.05 ± 0.00	9.98 ± 0.02	10.02 ± 0.02	10.04 ± 0.00	10.28 ± 0.08	10.02 ± 0.02	10.01 ± 0.01	10.05 ± 0.05	P > 0.05
3	10.09 ± 0.06	9.95 ± 0.05	10.00 ± 0.00	10.10 ± 0.00	10.00 ± 0.02	10.25 ± 0.05	10.15 ± 0.05	9.98 ± 0.08	P > 0.05
4	8.94 ± 0.14	8.90 ± 0.15	8.75 ± 0.25	8.50 ± 0.00	8.55 ± 0.05	8.50 ± 0.00	8.55 ± 0.05	8.45 ± 0.05	P > 0.05

NOTE : P > 0.05 = not significantly different

Table 8 : Changes in Ash on Dry Matter Content of Wheaten White Bread Flour During Storage

FLOUR BRANDS	ASH ON DRY MATTER CONTENT (%) AT								
	DAY 0	DAY 15	DAY 30	DAY 45	DAY 60	DAY 75	DAY 90	DAY 105	significant
1	0.60 ± 0.00	0.61 ± 0.02	0.63 ± 0.01	0.64 ± 0.01	0.59 ± 0.02	0.62 ± 0.00	0.67 ± 0.01	0.67 ± 0.02	P > 0.05
2	0.50 ± 0.00	0.62 ± 0.00	0.65 ± 0.01	0.65 ± 0.01	0.60 ± 0.02	0.65 ± 0.02	0.69 ± 0.01	0.66 ± 0.01	P > 0.05
3	0.68 ± 0.02	0.69 ± 0.01	0.70 ± 0.00	0.73 ± 0.03	0.67 ± 0.03	0.71 ± 0.02	0.69 ± 0.01	0.71 ± 0.01	P > 0.05
4	0.74 ± 0.03	0.76 ± 0.03	0.79 ± 0.07	0.84 ± 0.04	0.78 ± 0.06	0.81 ± 0.04	0.83 ± 0.05	0.88 ± 0.03	P > 0.05

NOTE : P > 0.05 = not significantly different

Table 9 : Changes in Fat Content (%) of Wheaten White Bread Flour During Storage

FLOUR BRANDS	FAT CONTENT (%) AT								
	DAY 0	DAY 15	DAY 30	DAY 45	DAY 60	DAY 75	DAY 90	DAY 105	significant
1	0.92 ± 0.00	0.94 ± 0.04	0.93 ± 0.01	0.95 ± 0.01	1.08 ± 0.01	0.84 ± 0.03	0.92 ± 0.01	0.93 ± 0.01	P > 0.05
2	0.95 ± 0.01	1.04 ± 0.01	0.85 ± 0.01	0.87 ± 0.01	1.08 ± 0.02	0.95 ± 0.04	0.86 ± 0.01	0.88 ± 0.03	P > 0.05
3	1.07 ± 0.00	0.86 ± 0.04	0.83 ± 0.03	0.81 ± 0.01	1.05 ± 0.01	0.89 ± 0.06	1.02 ± 0.03	0.84 ± 0.02	P > 0.05
4	1.02 ± 0.02	0.95 ± 0.02	0.94 ± 0.03	0.94 ± 0.02	1.02 ± 0.02	1.02 ± 0.02	1.04 ± 0.01	0.94 ± 0.02	P > 0.05

NOTE : P > 0.05 = not significantly different

Table 10 : Average ($\tilde{N}$) Summary on Quality Evaluation of Individual Brands of Flour

PARAMETERS	BRAND 1 $\tilde{N} \pm SD$	BRAND 2 $\tilde{N} \pm SD$	BRAND 3 $\tilde{N} \pm SD$	BRAND 4 $\tilde{N} \pm SD$	SIGNIFICANT
MOISTURE	$12.82^{b} \pm 0.11$	$12.77^{b} \pm 0.31$	$11.97^{a} \pm 0.58$	$13.56^{c} \pm 0.29$	P < 0.001
pH	6.03 ± 0.09	6.07 ± 0.04	6.12 ± 0.04	6.05 ± 0.03	P> 0.05
CARBOHYDRATE	65.31 ± 0.97	65.46 ± 0.65	65.87 ± 1.13	66.26 ± 1.12	P> 0.05
PROTEIN	$11.46^{b} \pm 0.04$	$11.47^{b} \pm 0.04$	$11.09^{b} \pm 0.15$	$10.24^{a} \pm 0.11$	P < 0.001
GLUTEN	$9.96^{b} \pm 0.08$	$10.23^{b} \pm 0.37$	$10.28^{b} \pm 0.48$	$8.64^{a} \pm 0.19$	P < 0.001
ASH	$0.56^{a} \pm 0.07$	$0.63^{b} \pm 0.06$	$0.69^{c} \pm 0.07$	$0.80^{c} \pm 0.02$	P < 0.001
FAT	0.94 ± 0.02	0.94 ± 0.03	0.92 ± 0.04	0.98 ± 0.11	P> 0.05
FUNGAL COUNT (X 10^{3}CFU/g)	$10.14^{b} \pm 3.13$	$4.50^{a} \pm 1\ 24$	$3.50^{a} \pm 0.87$	$3.36^{a} \pm 0.71$	P < 0.05

NOTE : Those with similar alphabet are not significantly different from each other.

P > 0.05 = not significantly different
P < 0.05 = significantly different
P < 0.001 = highly significantly different

III. Discussion

Total fungi counts of the flour during storage (Table 1) show no significant difference for only Brand 1 (x^2 = 55.988), but no significant difference was observed for the other flour Brands. Fungal counts from among the various Brands of flour show a significant difference (P = 3.153), flour Brand 1 has above 10_4 cfu/g and the other Brands below 5 × 10^3 cfu/g (Table 10).

Fungi thrive better at lower pH and this was reflected in the increase in the fungal counts at day 105 as the pH in all the flour Brands (Tables 1 and 4). Flour Brand 1 shows an increase in fungal count from 13.5 × 10^3 cfu/g 9day 90) to 14.0 × 10^3 cfu/g day 105) with a corresponding decrease in pH from 6.20 to 5.64. Corresponding in fungal counts were also observed in the other flour Brands (Tables 1 and 4). The increase in fungal counts for all the flour Brands at day 60 can be associated with the increase in moisture content of the flours. This finding is in agreement with the reports of Mashood *et al.* (2000) that mould growth in flour is favoured by high moisture content. *Penicillium* species was isolated throughout the storage period of the flour. This finding corresponds with previous studies that *Penicillium* species are among the dominant fungi in wheat and wheaten flour. Kent-Jones and Amos (1967) reported about 90% *Penicillium* of the total mould isolated from white flour and Weidenborner *et al.* (2000) also reported 15% *Penicillium* of the numerous mould counts (1.730 × 10^3 cfu/g) of white wheat flour.

Newer fungal groups begin to emerge as the storage progresses as a result of ecological succession with the yeast *Saccharomyces* being isolated at day 30 and 60 (Table 2). The isolation of yeast can be supported with increase in starch content at day 30 and 60. This finding correlates with previous report that yeast multiplication in flour occurs as a result of the high starch content (Kent-Jones and Amos, 1967). Other fungi such as the *Odium, Mucur, Geotrichum* were later isolated, this also is supported by previous studies that ecological succession occurs during storage of flour with *Penicillium* appearing after *Aspergillus* and followed later with *Mucur, Odium, Geotrichum* e.t.c. (Kent-Jones and Amos, 1967; Weidenborner *et al.,* 2000 and Schollenbeger *et al.,* 2002) a number of fungal species had been isolated from white wheat flour (Weidenborner *et al.,* 2000). Moulds usually contaminate the wheat from the field, despite the screening the wheat may pass through, the spores of the moulds cannot be completely eliminated since they are more resistant to heat and other chemicals. The effect can easily be observed after few days of storage of baked goods and even in the flour itself when left for long in the store. Mould growth usually produce undesirable odour in the flour products.

The increase in ash content of the flour may have encouraged proliferation of fungi. High ash content shows that there is much bran (the outer covering of the wheat grain) in the flour. This finding corresponds with the report of Schollenberger *et al.* (2002), that overall mould contamination was lower with decreasing ash content suggesting the localization of the fungi in the outer part of the wheat kernel. Total mould counts in all the flour Brands and during storage were above the standards of < 100 cfu/g (10^2 cfu/g) (Tables 1 and 10) recommended for Nigerian wheaten white flour (SON, 2000). Initially the ash contents for Brands 1 and 2 (Table 8) was within the acceptable limit value of < 0.65% (SON, 2000). Ash content however increased above the acceptable level for all the flours as from day 90 of storage. Flour Brands 3 and 4 have ash contents above 0.65 throughout the storage period (Table 8). There is however a significant difference in the ash content of the individual Brands of flour (P = 7.292) with flour Brands 1 and 2 having values of 0.56% and 0.63% respectively and Brands 3 and 4 of 0.69% and 0.80% respectively (Table 10).

The average fat content in the different brands flour shows no significant difference (P = 0.915) (Table 9). The value obtained for fat is acceptable as regarded <1.5% fat content for Nigerian white wheat flour (SON, 2000). Intermittent decrease was noticed in the protein content of the various brands of flour during storage. Flour brand 4 shows decrease in protein content from 10.02% (day 75) to 9.85% (day 105) and flour brand 2 shows a decrease in protein content from 11.64% (day 30) to 11.34% (day 90). The decrease noticed in the protein content of the flour corresponds with earlier reports that protein content flour decreases during storage (Sur *et al.,* 1993; Hruskova and Machova, 2002). The changes in protein content of the flour was however not significant, but average protein content for the individual brands of flour shows highly significant difference (P = 18.517) with brand 1 having 11.46% and brand 4; 10.24% (Table 10). Gluten content was seen to correlate with the total protein content as it also decreased slightly with storage (Table 6 and 7). This finding corresponds with previous reports of Sur *et al,* (1993) and Hrukova and Machova (2002).

IV. Conclusion

Wheaten white flour also referred to as the "all purpose" flour, because of unequal ability to produce gluten is used for several bakery products such as bread, pizzas, cakes and pastries, which are major supplements for breakfast. Wheat flour has high nutritional value, and hence is highly susceptible to spoilage. Fungi are primarily responsible for deterioration of grain especially when conditions of storage are favourable. This can be observed from the isolation of several moulds and yeast and the occurrence of ecological succession. There is therefore need to develop on methods to improve on and

preserve the quality of the flour for even longer period. This can be achieved by sourcing for high quality grade wheat and adequate monitoring and cleaning (screening) before milling. Good environmental hygiene practice and regular adequate cleaning of production lines will help to reduce wheat and flour contamination.

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