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Effect of Storage on Quality Characteristics of Wheat Flour

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ABSTRACT
Wheat is a good source of protein, minerals, dietary fibers and vitamins i.e., a good health-building food. Wheat flour is extensively used on an industrial scale in baked products, food concentrates and sweetmeats. In the current situation, millers as well as food Industries are facing several challenges in relation to the whole wheat flour due to its limited stability when compared to refined wheat flour. The germ of wheat represents around 3% of the whole grain and it holds 8-14 oil percentage, which is a rich source of vit E and linoleic acid. Due to the action of enzymatic as well as non-enzymatic pathways there occurs lipid degradation which one of the foremost causes of decrease in stability of whole wheat flour. An experiment was carried out to study the effects of temperatures while storing the wheat flour (at ambient temperature, at 37 ˚C and in cold storage) and storage period (up to six weeks) on the characteristics of wheat flour quality, as well as some of the chemical characteristics of flour. During the storage period each treatment was evaluated for moisture, acidity of wheat flour and gluten performances. It was observed that the moisture content, acidity of wheat flour increased rapidly at ambient temperature when compared to Cold storage (<10 °C) and at 37°C.The gluten content of wheat flour increased in all the threetemperatures at ambient, Cold storage (<10 °C) and at 37°C. At 37°C the gluten increase is more when compared to ambient, <10 °C because as temperature is increased there will be increase in the gluten formation. Moisture is the parameter that contributes to the oxidative degradation of lipids of wheat flour, as wheat flour consists of germ oil.
Key words: *Wheat flour, Quality characteristics of wheat flour, Storage of wheat flour and Gluten.*

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I. INTRODUCTION

1.1 Wheatgrain

Wheat grain is one of the most important food crops. Wheat is rich in various nutrition and easy for storage, transportation and can be converted into numerous types of food.Wheat flour being thefirst crop in the world to be used as a raw material for the production of Flour used products. Wheat flour is mainly used in the preparation of various products like bread, biscuits, sweetmeat products, vital wheat gluten and noodles.In the flour market, wheat dominates when compared to others. It is growing with CGAR of 4.3% over a forecast period of time.

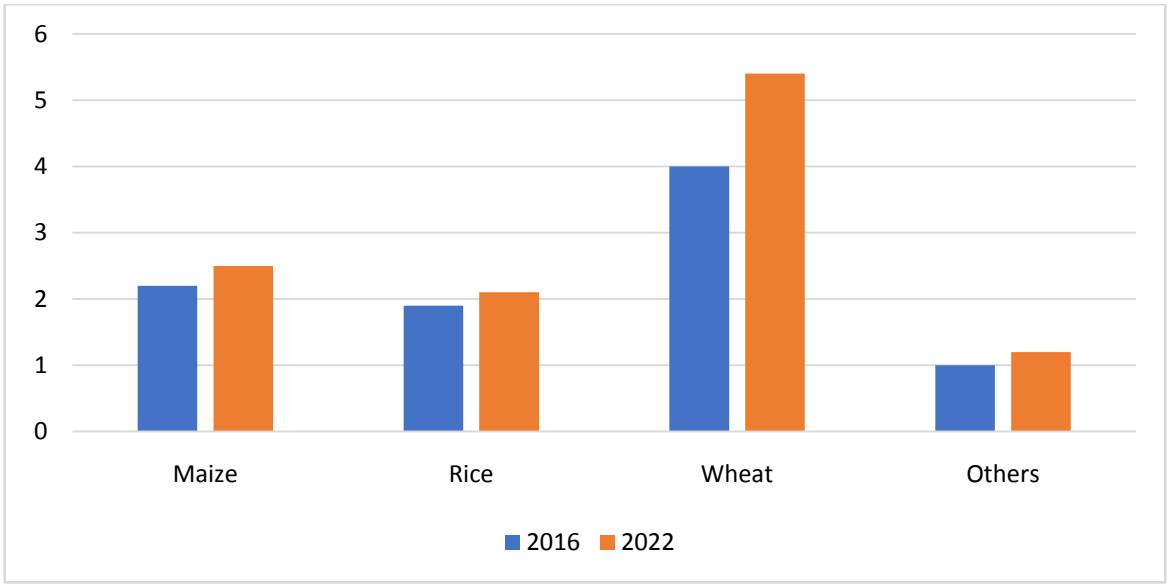

Fig1.1: Global flour market by Raw Material (Courtesy- Industry analysis forecast,2022)

Wheat is also used in production of beer brewing, ethanol . It is also used as a raw material for production of cosmetics, protein to replace meat, to makestraw compositesof wheat and also as animal feed.It is also rich in dietary fibresused in the treatment and prevention of disordersrelated to digestion, as it consists of wheat bran and wheat germ.

The wheat kernel has 3 parts endosperm, bran and wheat germ. These three parts have different nutrients and qualities

1. Bran

This is the outer coating and it makes up to 14.5%of the total kernel weight.
This wheat bran consists of proteins in trace quantity, trace minerals and is rich in dietary fibers.

2. Endosperm

It is the layer next to bran and constitutes about 83% of total kernel weight
Endosperm is rich in carbohydrates, protein,and iron.It is also a source of fibre.

3. Germ

It is the central part of wheat kernel constitutes about 2.5% of total weight
Germ is rich in Vitamin E(tocopherol) which is an essential nutrient and has antioxidant properties.It also consists of nutrients like phosphorous, thiamine, zinc and magnesium.

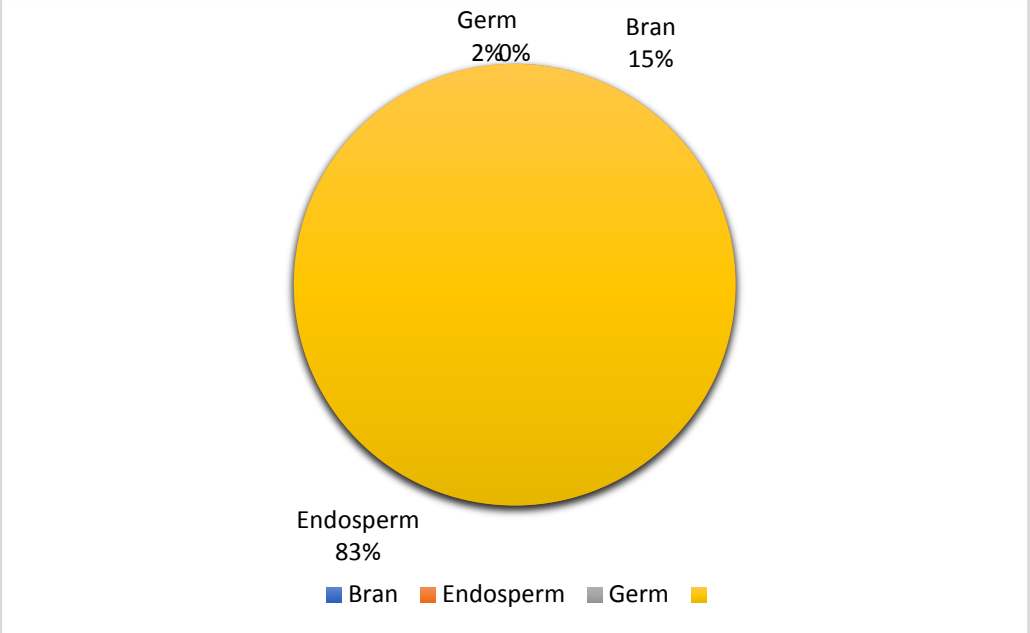

Fig 1.2: Parts of wheat kernel (SayaliPande*et al*, 2017)

1.2 Nutritional profile of wheat

Wheat gives around 20% of the food calories for the world's kin and is a public staple in numerous nations. Wheat is rich in catalytic elements, mineral salts, magnesium, calcium, potassium, sulphur, arsenic, silicon, manganese, zinc, chlorine, iodide, , vitamin E, and vitamin B. Wheat is the chief contributor of protein content of regular diet.

Table 1.1: Composition of wheat grain parts and products per 100g

Sl. No	Wheat flour	Protein[1]	Fat[1]	Carbohydrates[1]	Starch[1]	Total sugar	Thiamin[2]	Vitamin E[2]	Niacin[2]	Riboflavin[2]	Folate[3]
1	Wheat germ	26.7	9.2	44.7	28.7	16	2.01	22	45	0.72	-
2	Wheat bran	14.1	5.5	26.8	2	3.8	0.89	2.6	29.6	0.36	260
3	Whole meal flour	12.7	2.2	63.9	61.8	2.1	-	1.4	-	0.09	57

4	Wheat flour	12.6	2	68.5	66.8	1.7	0.3	0.6	1.7	0.07	51
5	White flour	9.5	1.4	77.6	76.1	1.5	0.1	0.3	0.7	0.03	22

Courtesy- Food Standard Agency (2002); 1 unit in grams ; 2 units are milligrams; 3 units are micrograms ; - no data given

1.3 Health benefits of wheat flour

As wheat flour contains supplements, issues like frailty, mineral lacks, gallstones, stoutness, asthenia, tuberculosis, pregnancy and breastfeeding issues are quickly worked on by consuming entire wheat. Copious of the wheat utilized for animals and poultry feed is a result of the flour processing industry. The supplements in it are stayed even subsequent to handling it into flour. Wheat flour is a powder produced using the crushing of wheat utilized for human feed.

1. High on fiber and support digestion
2. Lowers the risk of heart diseases
3. Reduces risk of stroke and obesity
4. Lowers the risk of type 2 diabetes
5. Reduces chronic inflammation

1.4 Storage and Quality parameters of wheat flour

Wheat flour in the food industries is stored for short period of time, protracted storage of these flours, will cause degeneration. Flour spoilage is caused due to:

i) Changes of chemical parameters, like protein or starch degradation, non-enzymatic oxidationsetc

ii) Changesin enzymatic parameters of wheat flour

iii) Changes in the of physical/ mechanical parameters, which might cause the invasion of microorganisms

Factors impacting flour deterioration are moisture, temperature, the presence of oxygen as well as carbon dioxide and capacity time. In these examinations, the bundling, stockpiling conditions, term of capacity and the flour boundaries dissected were different each time. The majority of them were restricted to one year of capacity or less dissected the dampness, wet gluten, acidity.

In the event that the dampness in flour increments it causes pervasion during the capacity. Dampness is the fundamental component which add to the oxidative decay of lipids, bringing about rancidity and furthermore increment the substance of FFA (free unsaturated fats). The distinction of dampness can be brought about by:

i) poor storage conditions

ii) substantialdifferences in the temperatureand

iii) Due to the pre-harvest weather conditions.

While the process of millingthe wheat cell ruptures and it diffusion oil. Hence during theprocessing, it retains highest percentage of tocopherol and storage of the germ will contribute to decreaseoxidation in the oil with a more percentage of polyunsaturated fatty acids. Thusly, it is critical to know the impacts that different capacity conditions might have on the oil quality and on the tocopherol focus.

Wheat inconstancies are called delicate, assuming gluten content is low and are called hard in the event that they have high gluten content. Hard flour, or bread flour, is more in gluten, with 12% to 14% gluten content, and mixture has flexible sturdiness holds its shape well once heated. Delicate flour is similarly less in gluten and subsequently brings about a portion with a better, brittle surface. The compound qualities of wheat flour changed quickly during this short capacity period. concentrated on the actual properties of gluten for a really long time and it was noticed a sluggish decline of the amount of cleaned out gluten.

The wheat flour is stored at different temperatures. It hasbeen specified that the chemical changes arose in the 1 week of milling process and lasted for almost 3 weeks, at ambient temperature wheat flour can be stored for very short period of time as there will be increase in moisture and acidity of flour. To increase the storage period of wheat flour it can be stored at higher temperature then ambient or at cold temperatures. If the flours are stored at cold temperatures (below 10°C) the enzymatic and non-enzymatic reaction of the flour decreases. At higher temperature (35 to 37°C) the moisture gets in control, as moisture gets in control the acidity of the wheat flour also gets in control.

Objectives of the study

1. To study thestorage effect on quality parameters of wheat flour at ambient temperature
2. To study the storage effect on quality characteristics of wheat flour at 37°C and at cold temperature (below 10°C)
3. To study the relationship between moisture and acidity of wheat flour.

II. REVIEW OF LITERATURE

2.1 Different types of flours used in biscuit preparation

Table 2.1: Different types of flours used in biscuit preparation

Sl.no	Name of biscuit	Type of flour used	Reference
1	Oat meal biscuit	Oat flour enriched with apple pomace	Pooja*et al*, 2020 (1)
2	Wheat-oats biscuit	Combination of Wheat flour and oat flour	Hoda, ElshawafandHussein,2018 (2)
3	Ragi biscuits	Ragi flour with oil seed flour blend	Videha, Pushpa, and Lalitha, 2016 (3)
4	Whole wheat cocoa biscuits	Whole wheat flour with cocoa encapsulated with grape skin extract	Roberta*et al*, 2019 (4)
5	Wheat- Millet biscuit	Refined wheat flour and little millet flour	Biradar *et al*,2020 (5)
6	Wheat biscuits	Refined wheat flour	MeenaGoswami *et al*,2020 (6)
7	Multi grain biscuits	Wheat flour, oat flour green gram and legumes flour	Veer Pal*et al*, 2018 (7)
8	Multi grain gluten free biscuits	Multi grain flour along with soya bean	Kinjal,SamrudhiShivkar and Anuradha, 2015 (8)
9	Multi grain biscuits	Buck wheat flour, chickpea flour along with chia seeds	Ravi Bhushan*et al*,2018 (9)
10	Wheat bran biscuits	Wheat flour along with bran, flax seeds and almond	Arpan and Sunita,2018 (10)

Sixteen kinds of biscuits were ready with all-purpose flour (Maida) to look at theadequacy of the rolls produced using maida with thatof those produced using blends of one of two oil-seedflours and either the white or the hued assortments of ragiflours and their malts. The current exploration work was completed to investigate the chance of usage of underutilized yet profoundly supplement rich little millet in treats. Little millet is a rich wellspring of protein, rough fiber, micronutrient like iron and can be used in bread kitchen items like treats. Wheat grain flour as halfway substitution of wheat flour ended up being much nutritious when contrasted with the wheat flour rolls. wheat grain flour expanded the substance of dietary fiber and many micro macro nutrients.

2.2 Nutritional factors of different flours

Table 2.2: Nutritional factors of different flours

Sl.no	Type of flour used	Nutritional factor	Health benefits	References
1	Whole wheat flour and pumpkin seed flour	Pumpkin seeds are rich in nutrients, medicinal properties, protein, oil, minerals and dietary fibers	Lower the chances of occurrence of many types of cancers such as lung and gastric cancer	Neeta Kumari*et al*, 2021 (11)
2	Wheat flour, finger millet flour and barley flour	Rich in nutrients such as vitamins, minerals, proteins as well as dietary fibers	Helps in reducing cholesterol, heart diseases and causes low obesity levels	C V Hemanth Kumar, 2020 (12)
3	Ragi, barley, jowar, bajra, soya bean and wheat grass powder	Good source of vitamins, minerals, antioxidants, protein, chlorophyll and active enzymes	Used for the treatment of acidity, colitis, astringent, laxative, diuretic and antibacterial	Manohar Shashank*et al*, 2021 (13)

4	Whole wheat atta	Excellent source of dietary fiber, niacin, vitamin E, riboflavin	support digestion, Lowers the risk of heart diseases, Reduces risk of stroke and obesity and lowers the risk of type 2 diabetes	Sayali*et al*, 2017 (14)
5	Oats and finger millet	Rich in dietary fibers, phytochemicals and nutritional value	Lowering the cholesterol and reducing risk of heart disease	Girame*t al.*, 2017 (15)
6	Millet flour, flaxseed flour and rice bran oil	Rich in carotenoid, lycopene, dietary fibers and omega- 3 fatty acids	Helps in prevention of various diseases cancer, osteoporosis, helps in digestion and also plays a major role in preventing metabolic disorder like diabetes	Daisy Sharma *et al*, 2017 (16)
7	Wheat flour	Protein, Vitamin A and E	protection against constipation, ischaemic, heart disease.	Pawan Kumar *et al*, 2011 (17)

Wheat is viewed as great wellspring of protein, minerals, B-bunch nutrients and dietary fiber for example an amazing wellbeing building food. Gluten makes bread batter remain together and enables it to hold gas. Wheat has a few therapeutictemperance; starch and gluten in wheat give intensity and energy; the internal grain coats, phosphates and other mineral salts; the external grain, thegenuinely necessary roughage the toxic part that helps simple development of guts; the microbe, nutrients B and E; and protein of wheat makes a differenceassemble and fix solid tissue. The raw grain, which is taken out during the time spent refining, is likewise plentiful in fundamental vitamin E, the absence ofwhich can prompt coronary illness.

2.3 Method used for analysis of quality parameters of wheat flour

Table 2.3: Method used for analysis of quality parameters of wheat flour

Sl.no	Quality parameter	Method used for analysis	Principle	Reference
1	Moisture	Karl Fischer method	Based on Oxidation reaction between iodine and SO_2	Eva *et al*,2012 (18)
2	Moisture	Oven method at 135 °C for 2 hours	Heats transfer and mass transfer	Harry and Betty, 2011 (19)
3	Moisture	Oven method at 105°C for 4 hours	Heats transfer and mass transfer	Hayfaand Les Copeland,2015 (20)
4	Gluten	Manual Method	Formation of dough and then washing starch to get gluten	Ravinder*et al*,2014 (21)
5	Gluten	Manual method	Formation of dough and then washing starch to get gluten	Wenjuan*et al*, 2020 (22)
6	Acidity	Soxhlet extraction	Solvent percolates into sample extracting the lipids	Derya*et al*, 2020 (23)
7	Moisture	NIR Spectrometer	Measures absorbance and reflection of light	Tomasz *et al*, 2020 (24)
8	Acidity	Soxhlet extraction	Solvent percolates into sample extracting the lipids	Capitani*et al*, 2011 (25)
9	Acidity	Alcoholic acidity	Ethanol used to estimate acidity of sample	Ravinder*et al*,2014 (26)
10	Moisture	Karl Fischer method	Based on Oxidation reaction between iodine and SO_2	Muhammad *et al*,2013 (27)

Moisture is the basic boundary of wheat flour as it starts the development of organisms. Moisture assurance is most significant and broadly involved estimations in the handling and testing of food sources. Dampness content assumes a critical part in laying out legitimate circumstances for safeguarding, storability and bundling of food items. Karl Fischer titration depends on Based on Oxidation response among iodine and SO2. It is utilized for both strong and fluid examples. Basic traditional method for moisture analysis is hot air-drying method. Drying in oven is done at different temperature and for different time period. NIR spectroscopy used near infrared rays to detect moisture is one of the methods. Acidity can be calculated by Soxhlet method using ethanol as solvent method followed by titration using NaOH. Alcoholic acidity can also be calculated using ethanol, keeping in dark for 24 hours later titration by NaOH. From the papers it was studied that gluten is the protein which is important in biscuit preparation for hard variety of biscuits. It can be quantified on dry bases. Washing off the starch and keeping the gluten in oven.

2.4 Storage conditions of wheat flour

Table 2.4: Storage conditions of wheat flour

Sl.no	Storage period	Type of packaging used for storage	Attributes evaluating for shelf life	Storage temperature	Reference
1	30 days	Aluminium boxes	Fat acidity (FA) and pH	15 °C	Preeti*et al*,2016 (28)
2	60 days	Penetrable paper bags and sealed containers	biochemical stability, constancy, extensibility, resistance, water absorption and Gluten Index	Room temperature and cold storage	Eloise *et al*,2021 (29)
3	30 days	LDPE bags	Proximate composition, Crude fibre, FFA	ambient temperature	Akhilesh*et al*,2015 (30)
4	60 days	-	Proximate analysis, enzymatic actions	Cold storage	Navneet, 2018 (31)
5	12 months	LDPE bags	Fat acidity, moisture, gluten	4, 20, and 30°C	Hayfaand Copeland, 2015 (32)
6	13 weeks	Boxes	Gluten, moisture and protein	40°C, 45°C, 50°C, and 55°C	Linfeng and Rolando ,2013 (33)
7	60 days	Air tight containers	Proximate analysis (moisture and Ash	Ambient temperature	Sudha and Leelavati, 2008 (34)

Flour treatments having different moisture levels for example 13.5, 13,12,11,10 and 9% were gathered in polypropylene packs. During the capacity time of 60 days, every treatment was assessed for general organization, bug invasion, shape development and all out iron. Dampness affects unrefined protein, rough fat, shape development and bug pervasion. Form development and bug pervasion was more in medicines having higher dampness during capacity while the medicines with lower dampness content (9%) showed no invasion. It is presumed that 9 and 10% dampness content is reasonable for stockpiling dependability and longer timeframe of realistic usability of wheat flour. study completed by the that can't keep the fragile quality coming about because of the wheat grain dampness 15% for over a half year and a degree 25˚C, or over 15 days for a precise consequence of the wheat moistness of 18% under 25˚C and weakening all the more quickly in 34˚C degree at this degree of humidity quality. Also, going against the norm, it was expressed that showed when the flour stockpiling at 25˚C de peroration rate all the more rapidly and induced through disintegration lipolysis contrasted and flour put away on 12˚C.

his paper presents a focus on the effect of limit conditions on wheat flour quality for a long while. Such audit may be of interest for research projects drove over huge stretches. Wheat flours were taken care of in two sorts of packaging (vulnerable paper sacks and watertight compartments) and at two temperatures (enveloping temperature and a cool additional room). Picked attributes limits were evaluated regularly, for instance, manufactured strength, consistency, extensibility, hindrance, water digestion, Solvent Retention Capacity and Gluten Index Performance. Similarly, Near-Infrared Spectroscopy was used to screen the flour's turn of events and models were used to expect explicit limits. The results showed that limit at incorporating temperature incited basic changes of flour limits and baking displays, however limit at low temperature protected the hidden idea of the flour. A useful idea is to lean toward limit at low temperature in a decent compartment to prevent association with oxygen and dampness take-up.

III. MATERIALS AND METHODLOGY

3.1 Collection of whole wheat flour sample

The wheat flour in Britannia Industries Ltd, Bidadi was supplied byXYZroller mills pvt ltd. The sampling of the was done from 8 bags from a total lot of 300 bags(15000kgs).

3.2 Storage circumstances of wheat flour

Wheat flour in the industry was preserved in 50 kgsgunny bags. The wheat flour bags (bags were made up of polypropylene) were stored at different temperature at ambient, Cold storage(<10°C) and at 37°C. The moisture,fat acidity and gluten changes were determined after 5 days,10 days, up to 45 days of storage at different temperatures.

3.3 Moisture analysis of wheat flour

Hot air oven method

Moisture determination is most important and widely used measurements in the processing and testing of foods. Dampness or moisture is how much water present in a framework or in an example, communicated as a rate. Dampness content assumes a huge part in laying out legitimate circumstances for protection, storability and bundling of food items.

In the estimation of the moisture content in Wheat flour the standard oven method was adapted the petri dish was kept in oven for 10 minutes to ensure there is no water content and dish is completely dry, then the petri dish was taken from the oven a cooled in the desiccator after cooling the empty dish was weighed and noted down that is W1. Then 10g of sample was added into petri dish weight was noted down that is W2 and then petri dish was kept in oven with lid open for 2 hours for 135°C, until the constant weight was obtained. The petri dish lid was closed while taking out of oven after 2 hours and placed in desiccator to cool completely, then after cooling the petri dish weight was noted down that is W3 and the Calculation was carried out.

Calculation:

Moisture (%) = [(W2-W1)/(W2-W)] *100

Were,

W= Weight in grams of empty Petri dish

W1= Weight of Petri dish + sample before drying in g

W3= WeightPetri dish + sample after drying in g

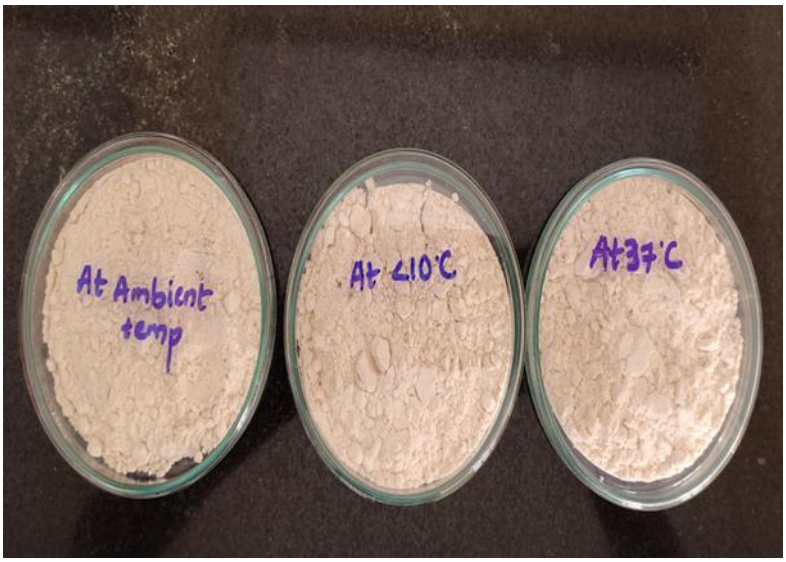

Fig 3.1: Wheat flour samples

Fig3.2: Hot air oven

Moisture analysis by KarlFischer titration method

KF titration is a method used for the moisture content analysis present in both solid and liquid sample. The Karl Fischer reagent which comprises of sulphur dioxide and iodine responds with the water present in sample to produce sulphur trioxide and hydrogen iodide.

Initially add methanol to the drying beaker neutralizer the methanal by addition Karl Fischer reagent. second step is determination of factor, for factor determination add 10 µl of distilled water. And continue the factor determination.Third step is analysis of moisture in sample. Accurately weigh the wheat flour sample about 0.2 to 1 gram and dissolved in KF methanol. The KF reagent starts and titration carried out the endpoint is detected .

Fig 3.3 Karl Fischer Titrator

3.4Estimation of acidityof wheat flour

Soxhlet method

Fat content in the sample is determined by Soxhlet method. Fat substance is assessed by extricating the fat from test utilizing a dissolvable, then deciding the heaviness of the fat recuperated.Later the measure of fat acidity reflects the number of fatty acids which is present in oils/fats. It is a continued procedure of fat determination process.

The total fat present in wheat flour was estimated by Soxhlet procedure that is first the empty thimble weight was weighed (T1) and then 10g of finely powdered sample was added in the thimble and thimble was weighed (T2). Then petroleum ether was the organic solvent used for the extraction process. Petroleum ether is non-polar solvent which forms a homogeneous mixture and is of low cost. Boiling point of petroleum ether is 70°C. The

empty weight of round bottom flask was noted down (RBF1). Petroleum ether is added to the round bottom flask. The flask is attached to an extractor and followed with condenser. The thimble is placed inside the extractor and round bottom flask is placed on heating mantle at 70°C. The petroleum ether boils in the round bottom flask and get vaporized and condensed back through extractor and then back to round bottom flask. The Soxhlet process was made to run for completion of the twenty cycles and then the fat gets settled at the bottom of round bottom flask and the flask is weighed (RBF2).

Calculation:
Fat (%) = [(T2-T1)/(RBF2-RBF1)] * 100
Were,
T1= empty thimble weight
T2= thimble weight with sample
RBF1= empty round bottom flask
RBF2= round bottom flask weight after recovering the solvent
Once the fat is extracted by Soxhlet procedure, to the fat obtained in the round bottom flask add 50 ml of 95% of ethanol and add few drops of phenolphthalein indicator. Titrate it against 0.05 N of NaOH until it turns to pink colour. Acidity of extracted fat is calculated by using the following formula:
Acidity of extracted fat = (burette reading * normality of NaOH * 28.2) / (RBF2-RBF1)
Were,
RBF1 = empty round bottom flask
RBF2 = round bottom flask weight after recovering the solvent

Fig 3.4: Soxhlet apparatus for fat extraction

Alcoholic acidity
Weigh 5 g of test (dried example) into a tapered stoppered carafe and add 50 ml of 90% liquor (by volume), recently killed against phenolphthalein. Plug, shake and permit representing 24 hours, with intermittent shaking. Channel the alcoholic concentrate, through a dry channel paper. Titrate 10ml of the consolidated alcoholic concentrate against standard sodium hydroxide arrangement involving phenolphthalein as marker. Work out the level of alcoholic sharpness as sulphuric acid
Calculation:
Alcoholic acidity=
(24.52 *Titre value * N of NaOH)/ Mass in g of sample taken

3.5 Estimation of gluten content in wheat flour

Weigh precisely around 25 g of the wheat flour into a dish. Add around 15 ml of water to the material and manipulate it into a batter, accepting consideration that quite far, all the material is taken into the mixture. Keep the batter in a container, cover it with water and let represent 60 minutes. Eliminate the mixture and ply it tenderly under a flood of regular water, holding it over a piece of silk or nylon smearing fabric, taking consideration, particularly in the beginning phases, to hold all the gluten while the starch and grain wash away. Add to the primary gluten that could have been washed away and held with the grain on the blasting material. Spread the wet gluten however much as could be expected into a flimsy layer. Move any buildup adhering to the spatula to the porcelain dish. Place the porcelain dish in an air broiler kept up with at 105°C for six hours.

Cool in a desiccator and gauge. Heat again the porcelain dish for one more hour in an air broiler keep up with at 105°C Cool in a desiccator and gauge. Rehash this course of warming for 60 minutes, cooling and weighing till the contrast between two progressive weighing is under 2 mg. Note the least weight.

Calculation:
Gluten (On dry basis) % by weight=10000 (W2-W1)/W (100-M)
Were,
W2 = Weight of porcelain dish with dry gluten in g,
W1 = Weight of empty porcelain dish in g,
W= Weightof the wheat flour sample taken in g, and
M =Moisture %

IV. RESULTS AND DISCUSSION

4.1 Moisture study of wheat flour

Oven method

Moisture analysis was carried out by oven method (at 135°C for 2 hours) for the wheat flour sample stored at ambient temperature, cold storage (<10°C) and at 37°C. It was carried out on 5^{th}, 10^{th} and so on till 45^{th} day during storage. It was observed that the moisture of the wheat flour stored at ambient temperature increased rapidly when compared to wheat flours stored at cold temperature and at 37°C (Table 4.1)

Fig 4.1: Petri dishes with wheat flour samples kept for drying in the oven

Table 4.1: Moisture content (%) of the wheat flour at different temperatures by hot air oven method

Day	**Temperature**		
	Ambient	37°C	<10°C
1	10.78	10.78	10.78
5	10.87	10.81	10.76
10	11.21	11.10	10.99
15	11.29	11.19	11.01
20	11.97	11.63	11.37

25	12.63	11.91	11.40
30	13.21	12.01	11.43
35	13.69	12.30	11.67
40	14.17	12.51	11.81
45	14.40	12.90	11.89

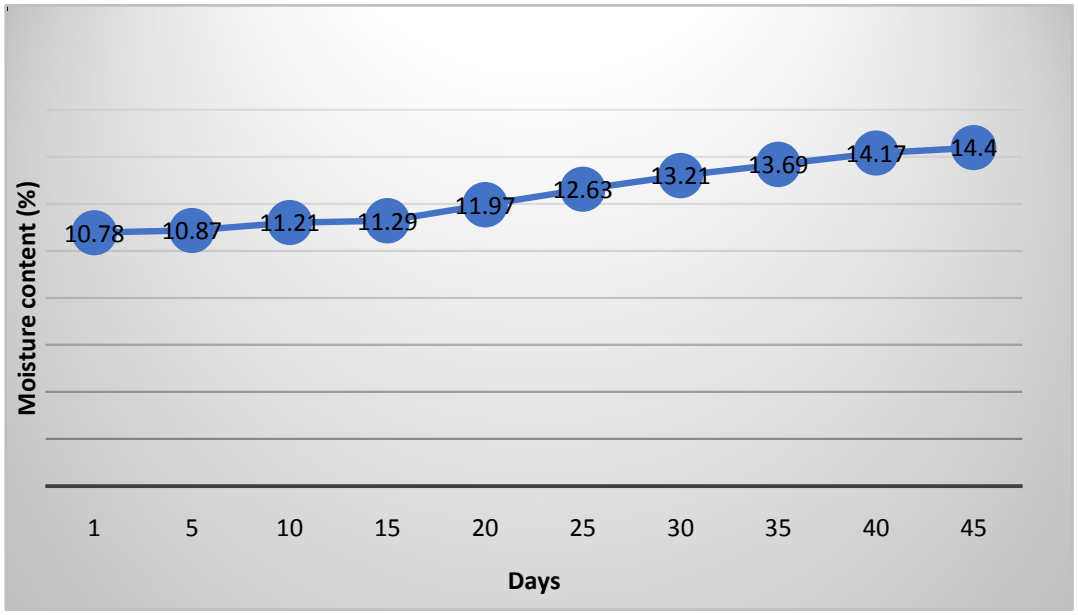

Fig 4.2: Moisture content (%) of the wheat flour at ambient temperature by hot air oven method

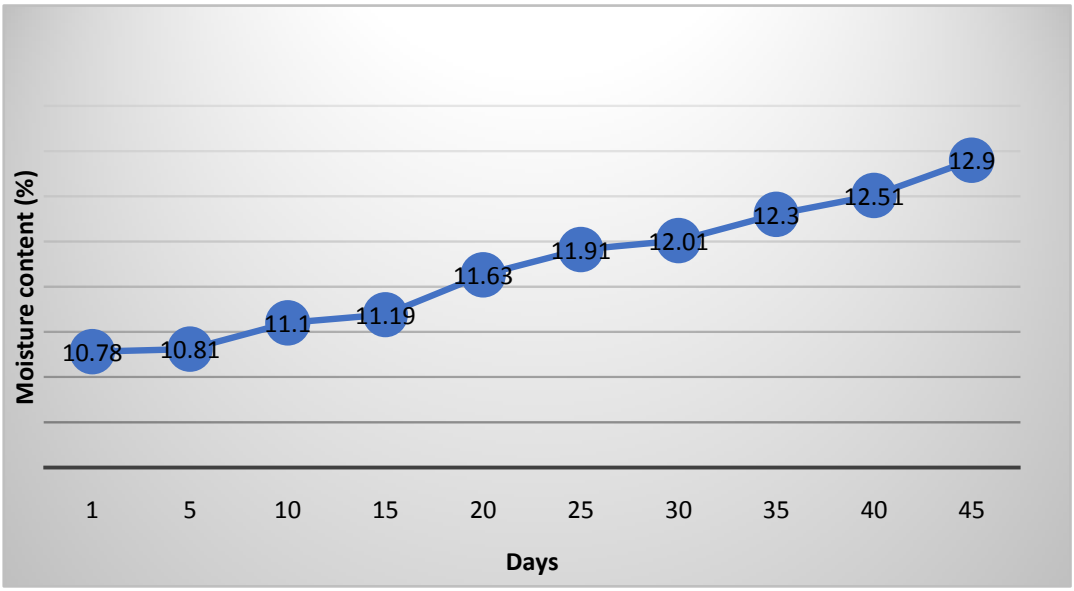

Fig 4.3: Moisture content (%) of the wheat flour at 37°C by hot air oven method

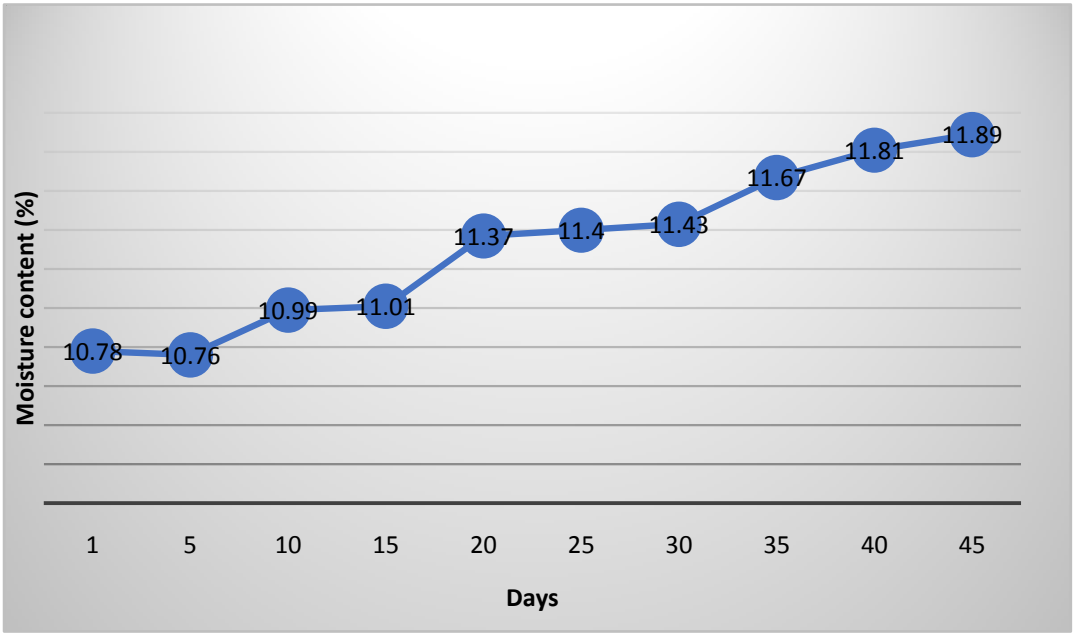

Fig 4.4: Moisture content (%) of the wheat flour at <10°C by hot air oven method

Karl Fischer

Moisture analysis was carried out by Karl Fischerfor the wheat flour sample stored at ambient temperature, cold storage (<10°C) and at 37°C. It was carried out on 5th, 10th and so on till 45th day during storage. It was observed that the moisture of the wheat flour stored at ambient temperature increased rapidly when compared to wheat flours stored at cold temperature and at 37°C (Table 4.2)

Table 4.2: Moisture content (%) of the wheat flour at different temperatures by Karl Fischer method

Day	**Temperature**		
	ambient	37°C	<10°C
1	10.69	10.69	10.69
5	10.81	10.91	10.81
10	11.01	10.74	10.99
15	11.45	11.19	11.21
20	11.38	11.20	11.06
25	11.98	11.34	11.09
30	12.32	11.17	11.23
35	12.99	11.19	11.45
40	13.34	11.45	11.31
45	13.87	11.61	11.30

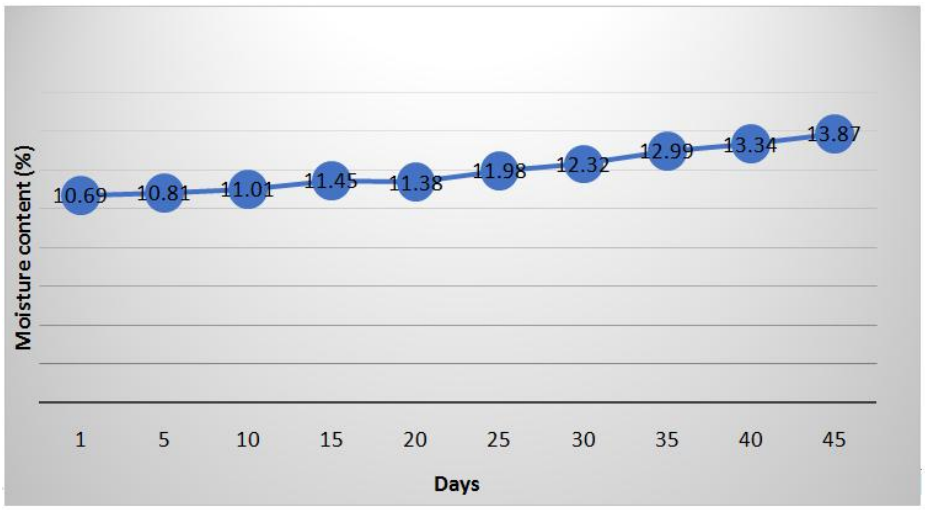

Fig 4.5: Moisture content (%) of the wheat flour at ambient temperature by Karl Fischer titration method

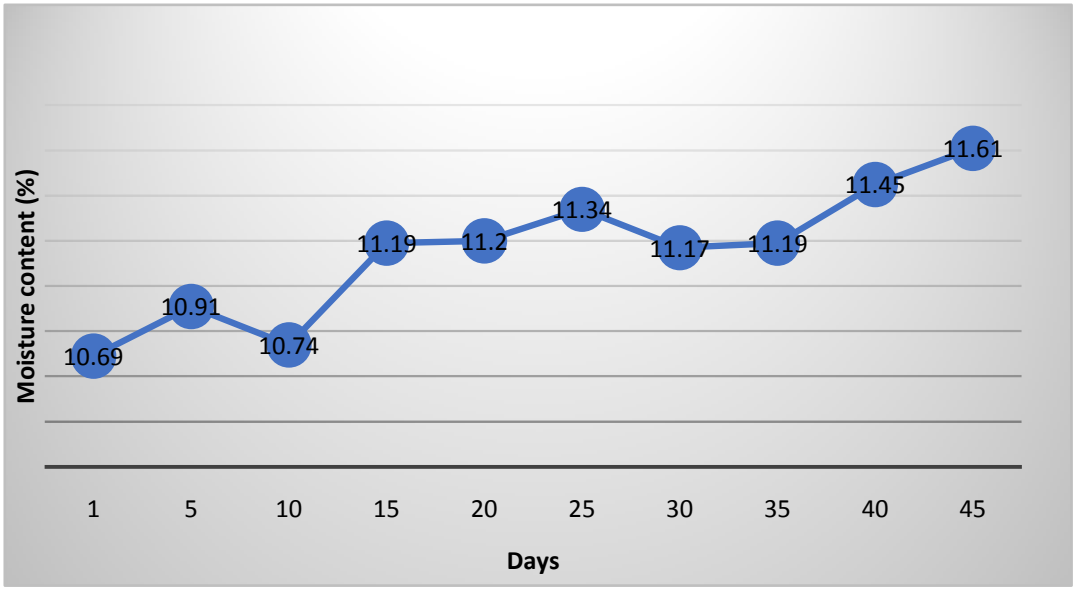

Fig no 4.6: Moisture content (%) of the wheat flour at 37°C by Karl Fischer titration method

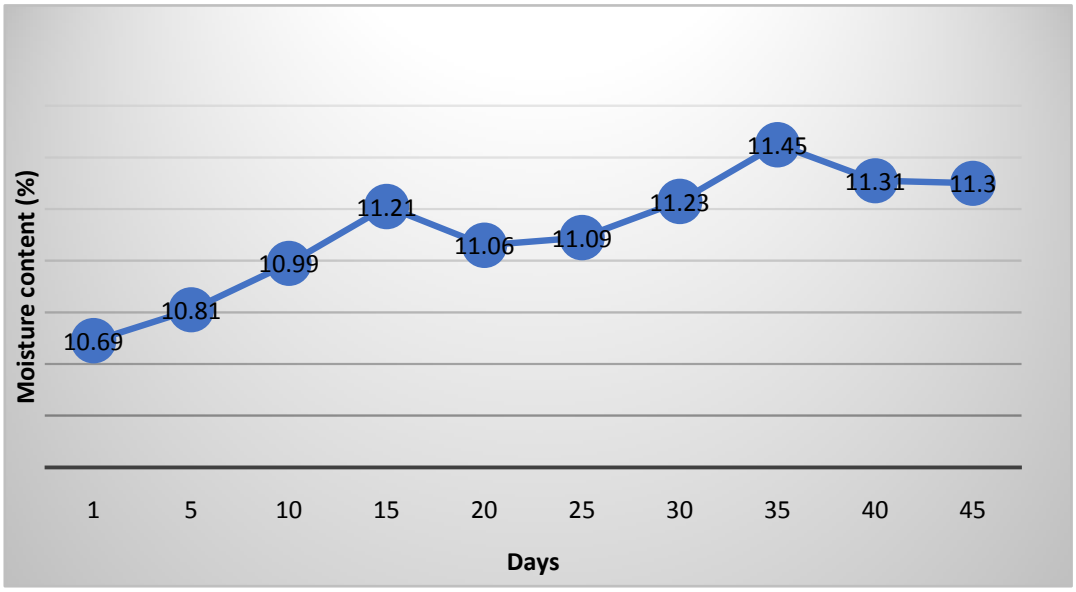

Fig 4.7: Moisture content (%) of the wheat flour at <10°C by Karl Fischer titration

4.2 Estimation of Acidity (%) of the wheat flour

Soxhlet method

Acidity of extracted fatfor the wheat flour sample stored at ambient temperature, cold storage (<10°C) and at 37°C was carried out by Soxhlet method. It was carried out on 5th, 10th and so on till 45th day during storage. It was observed that the acidity of extracted fat increased in the wheat flour stored at ambient temperature when compared to wheat flours stored at cold temperature and at 37°C (Table 4.3)

Fig 4.8: Titration process adapted for Acidity of extracted fat

Table 4.3: Acidity of extracted fat (%) of the wheat flour at different temperature

Day	Acidity of extracted fat (%)		
	ambient	37°C	<10°C
1	3.07	3.07	3.07
5	3.17	3.09	3.08
10	3.29	3.04	3.00
15	5.71	4.72	3.21
20	6.12	4.90	3.22
25	6.07	4.87	3.30
30	6.23	5.24	3.40
35	7.34	5.91	3.60
40	7.97	5.90	4.01
45	8.04	6.40	4.09

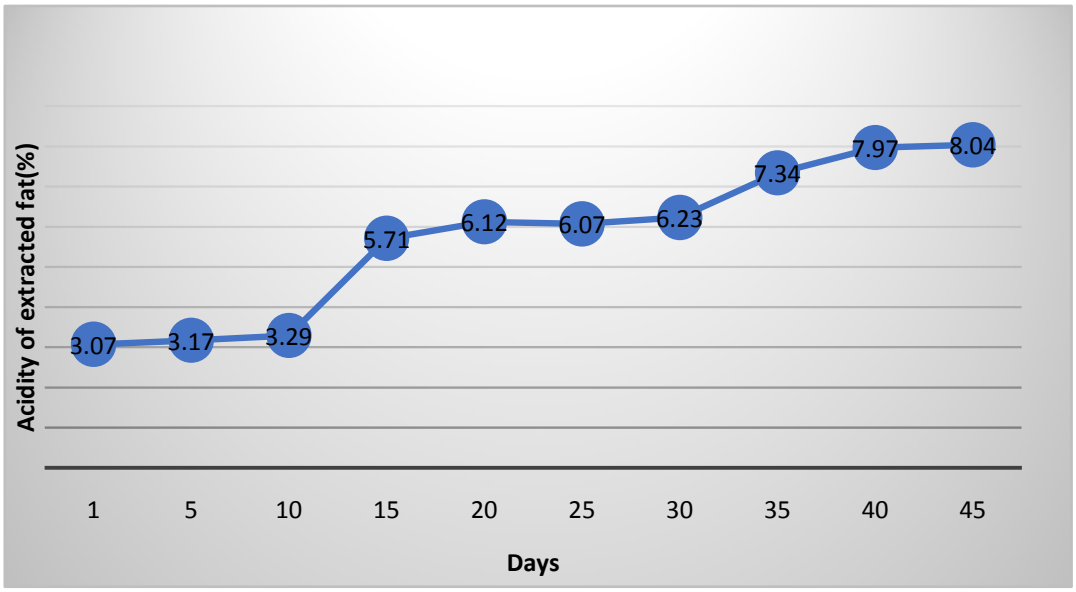

Fig 4.9:Acidity of extracted fat (%) of the wheat flour at ambient temperature

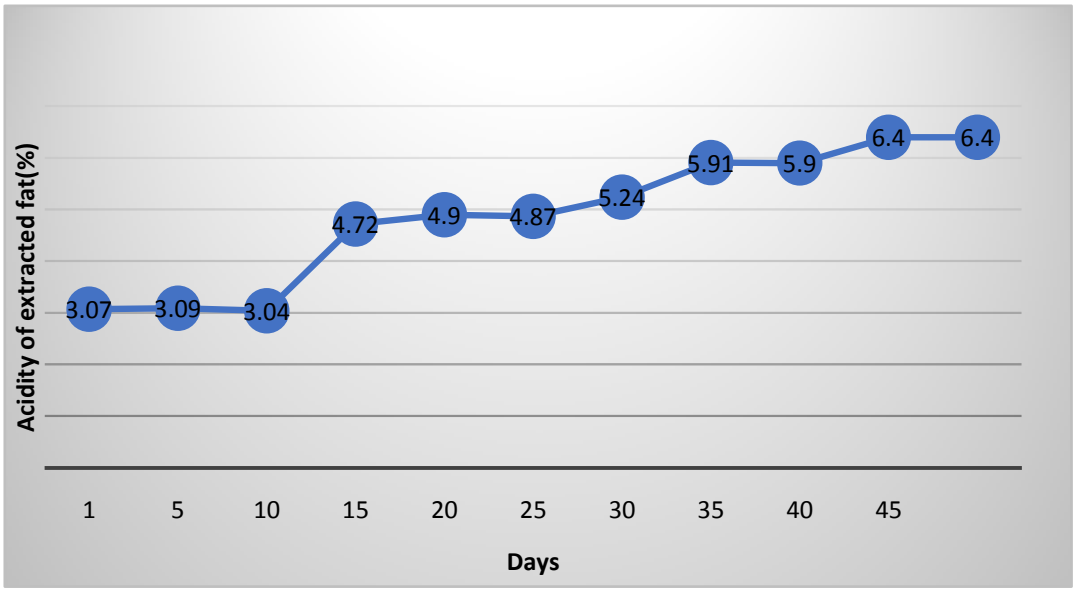

Fig 4.10: Acidity of extracted fat (%) of the wheat flour at 37°C

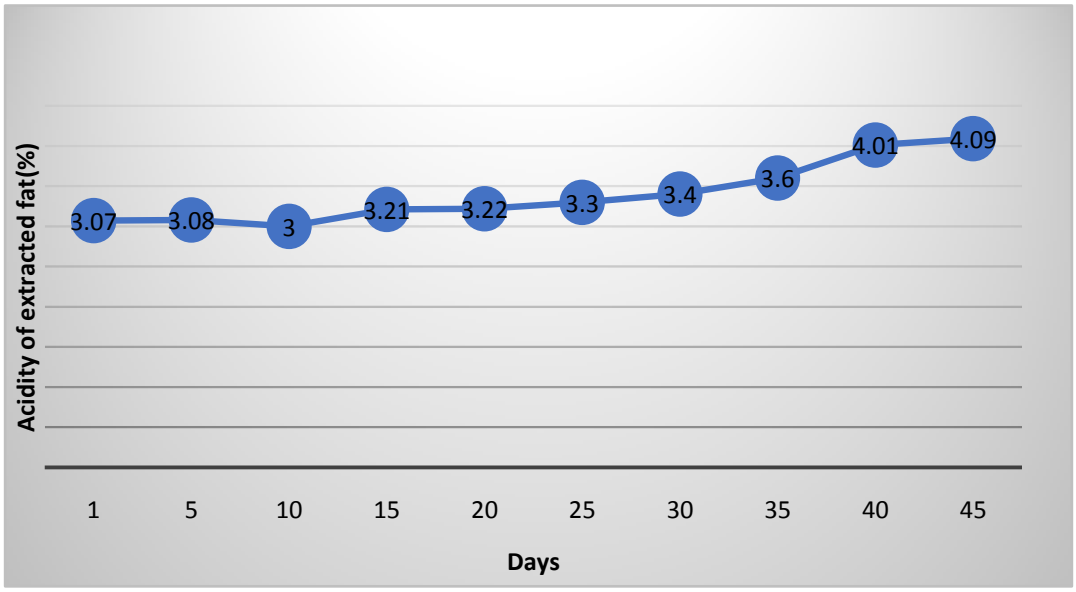

Fig 4.11: Acidity of extracted fat (%) of the wheat flour at <10°C

Alcoholic acidity

Alcoholic acidity of the wheat flour sample stored at ambient temperature, cold storage (<10°C) and at 37°C was carried out. It was carried out on 5th, 10th and so on till 45th day during storage. It was observed that the alcoholic acidity increased in the wheat flour stored at ambient temperature when compared to wheat flours stored at cold temperature and at 37°C(Table 4.4)

Fig 4.12: Filtration process adapted for alcoholic acidityacidity

Fig 4.13: Titration process adapted for alcoholic

Table 4.4:Alcoholic acidity (%) of the wheat flour at different temperatures

Days	Alcoholic Acidity (%)		
	ambient	37°C	<10°C
1	0.09	0.09	0.09
5	0.09	0.09	0.09
10	0.11	0.09	0.11
15	0.12	0.11	0.11
20	0.17	0.12	0.12
25	0.18	0.12	0.13
30	0.18	0.12	0.13
35	0.19	0.13	0.13
40	0.19	0.14	0.13
45	0.19	0.15	0.13

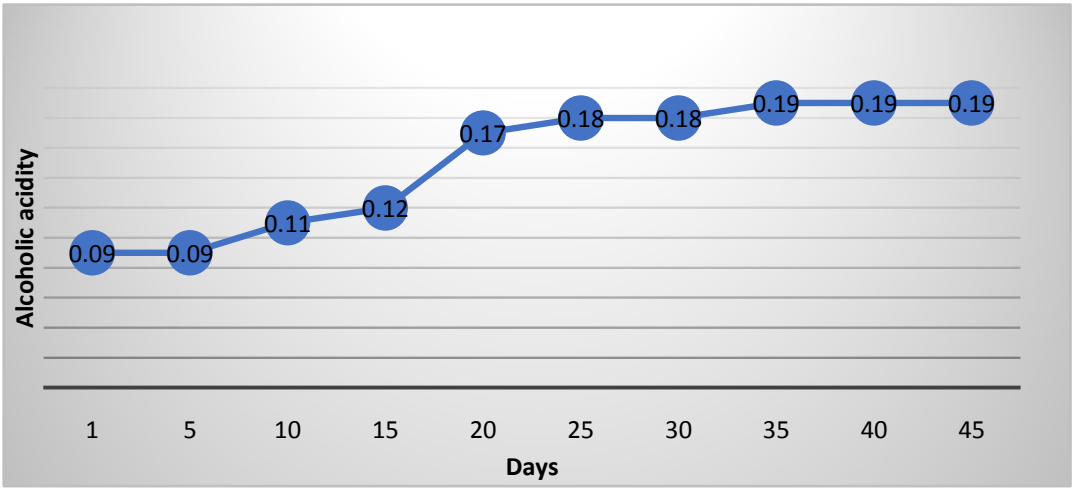

Fig 4.14:Alcoholic acidity (%) of the wheat flour at ambient temperature

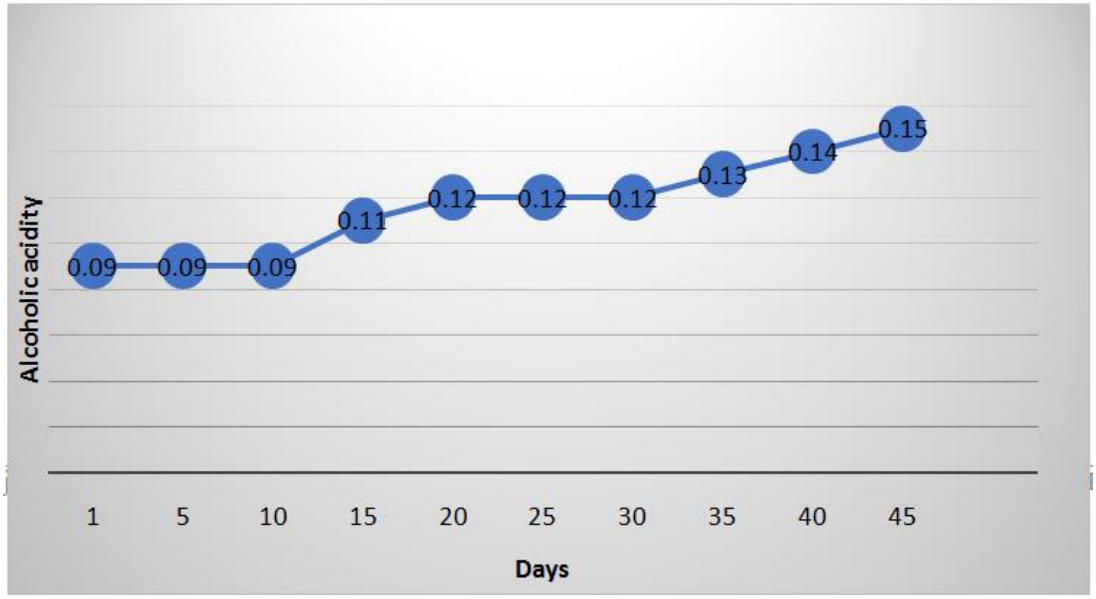

Fig 4.15:Alcoholic acidity (%) of the wheat flour at 37°C

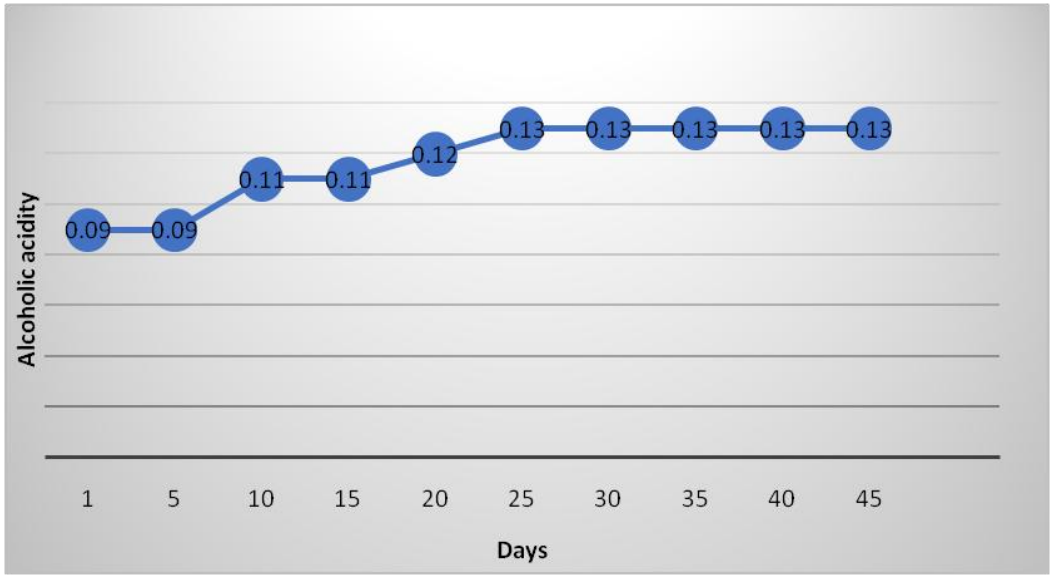

Fig 4.16: Alcoholic acidity (%) of the wheat flour at<10°C

4.3 Estimation of gluten content in wheat flour

Gluten content of the wheat flour sample stored at ambient temperature, cold storage (<10°C) and at 37°C was carried out. It was carried out on 5th, 10th and so on till 45th day during storage. It was observed that there was increase in the gluten content of wheat flour stored at all the three temperatures.(Table 4.5)

Fig 4.17: Gluten left after washing away starch

Fig 4.18: Wet gluten

Fig 4.19: Dry gluten after drying in hot air oven

Table 4.5: Dry gluten (%) of the wheat flour at different temperatures

Day	Dry Gluten (%)		
	Ambient	37°C	<10°C
1	9.47	9.47	9.47
5	9.55	9.53	9.51
10	9.67	9.50	9.61
15	9.62	9.51	9.71
20	9.64	10.20	9.69
25	9.71	10.11	9.77
30	9.90	10.30	9.81
35	10.10	10.47	10.02
40	10.12	10.46	10.13
45	10.20	10.67	10.20

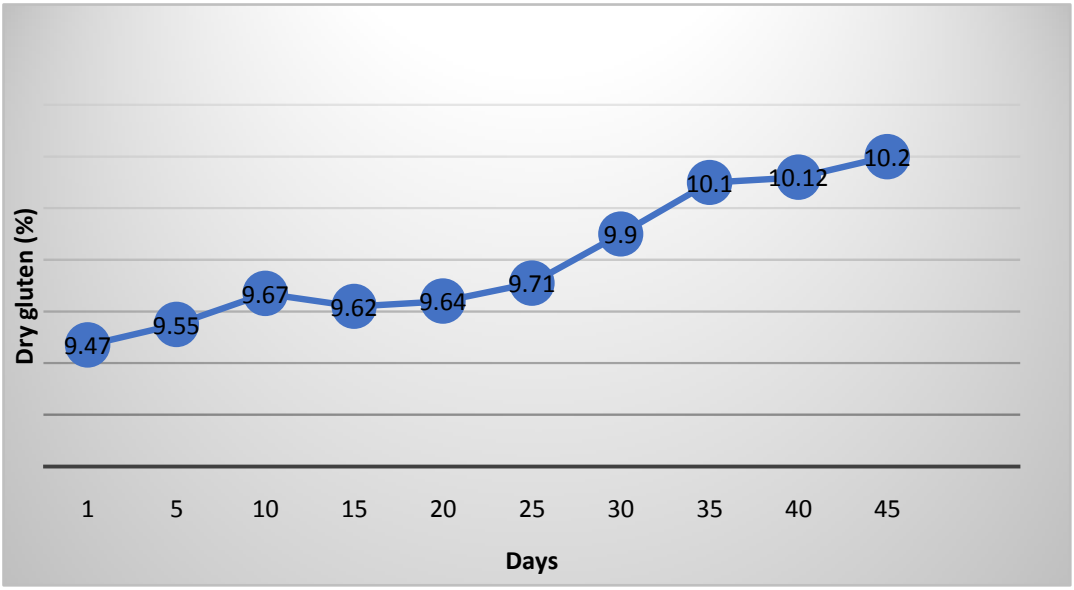

Fig 4.20: Dry gluten (%) of the wheat flour at ambient temperature

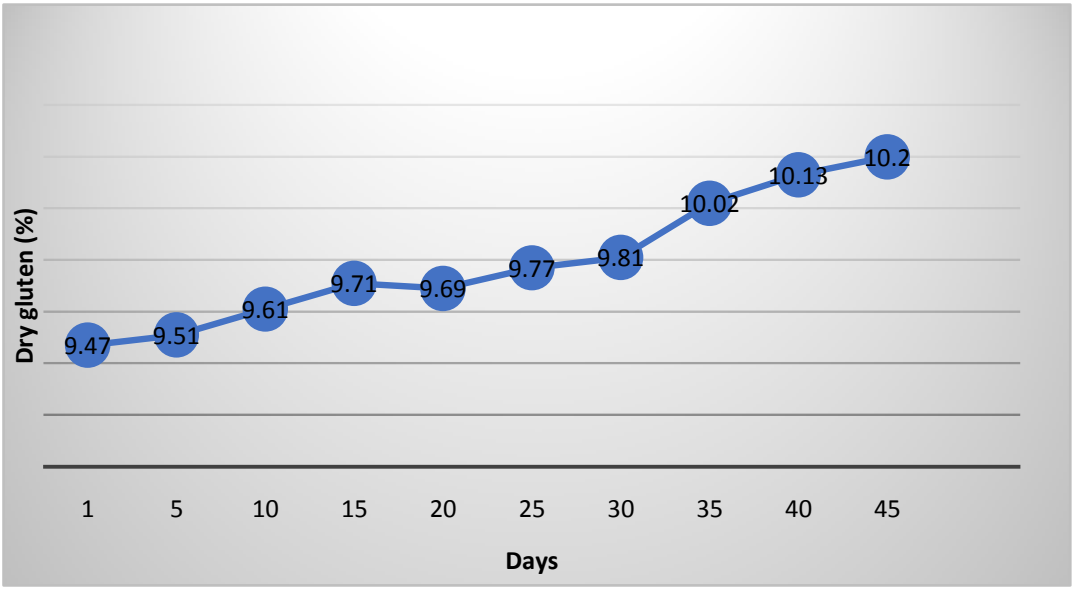

Fig 4.21: Dry gluten (%) of the wheat flour at <10°Ctemperature

4.4 Relationship between moisture and acidity of wheat flour

To find the relationship of moisture and acidity of wheat flour average moisture content of both oven and Karl Fischer titration method have been considered (Table No). Acidity of wheat flour is considered by taking average of alcoholic acidity and acidity of extracted fat. (Table 4.6)

Table 4.6: Average moisture content of Oven and Karl Fischer titration method of wheatflour

Day	**Temperature**		
	ambient	37°C	<10°C
1	10.72	10.73	10.73
5	10.83	10.86	10.78
10	11.11	10.92	10.99
15	11.37	11.19	11.11
20	11.67	11.41	11.21
25	12.30	11.62	11.24
30	12.76	11.51	11.33
35	13.34	11.74	11.56
40	13.75	11.98	11.56
45	14.13	12.25	11.59

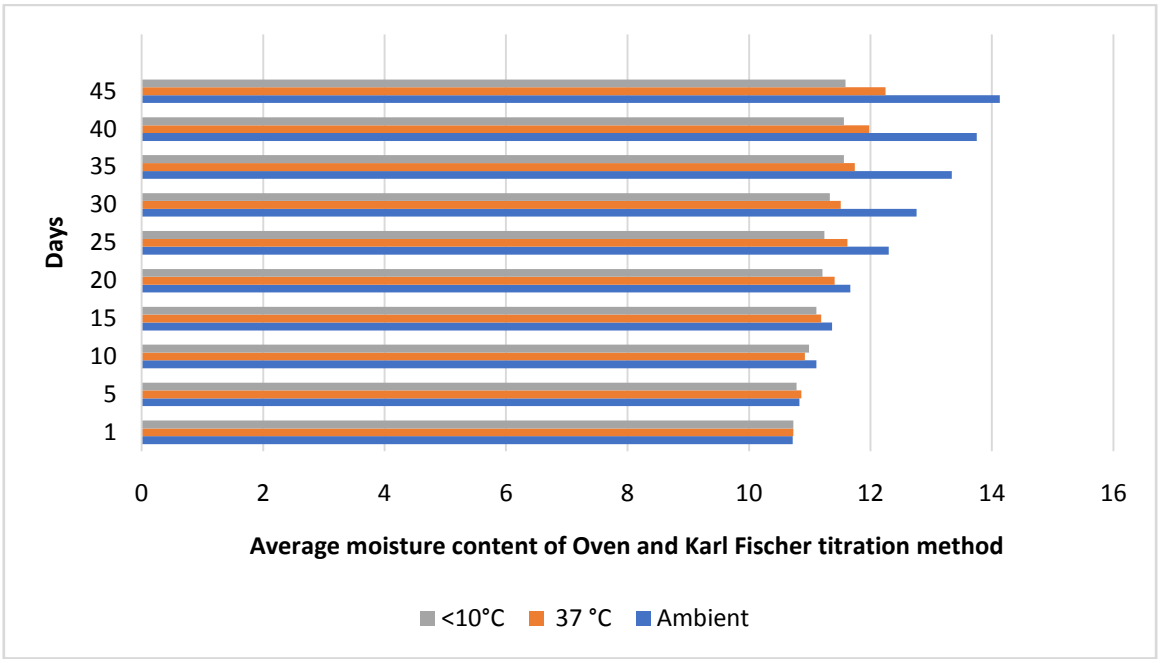

Fig 4.22:Comparison of moisture content of wheat flour stored at different temperature

Table 4.7: Average of acidity of extracted fat (%) and alcoholic acidity

Day	**Temperature**		
	ambient	37°C	<10°C
1	1.58	1.58	1.58
5	1.63	1.59	1.58
10	1.70	1.99	1.55
15	2.91	2.41	1.66
20	3.14	2.51	1.67
25	3.12	2.49	1.71
30	3.20	2.68	1.76
35	3.76	3.02	1.86
40	4.08	3.02	2.07
45	4.11	3.27	2.11

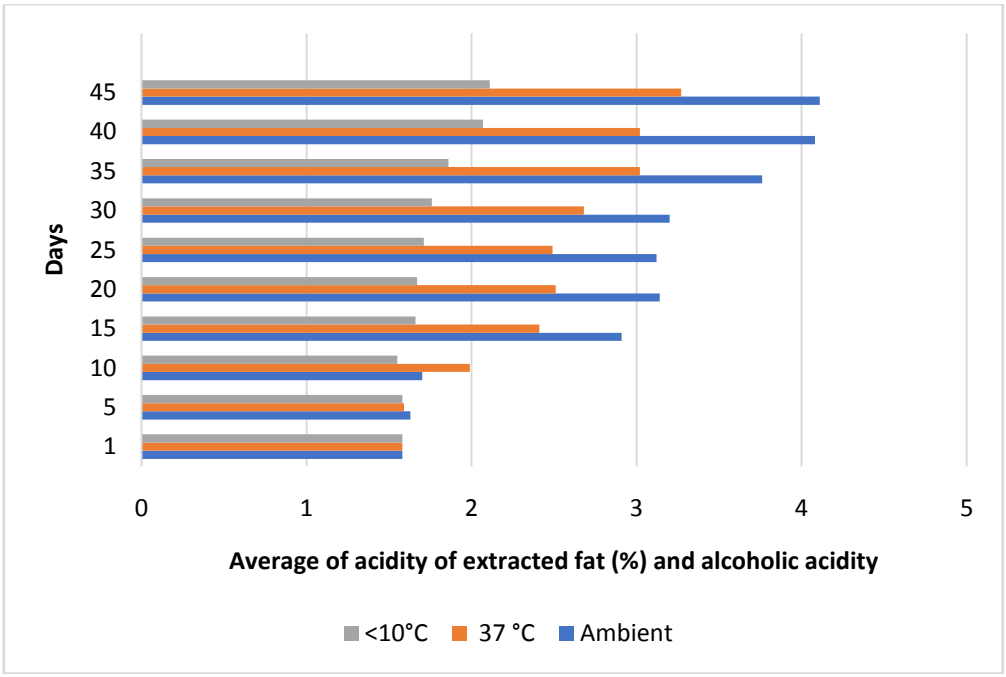

Fig 4.23 Comparison of acidity of wheat flour stored at different temperature

From Fig 4.22 and 4.23 it has been observed that as moisture content increases the acidity of wheat flour has also been increased. Moisture is the parameter that contributes to the oxidative degradation of lipids of wheat flour, as wheat flour consist of germ oil.This ultimately results in the rancidity of wheat flour. It also increases the content of free fatty acids of wheat flour, HenceBoth moisture and acidity of wheat flour are directly proportional to each other.

V. CONCLUSION

The sample was collected from 50kgs wheat flour bags and were stored in polypropylene bags and they were stored at ambient, Cold storage (<10 °C) and at 37°C. For every 5 days the moisture, acidity and gluten percentage were checked up to 45 days.It was observed that the moisture content, acidity of wheat flour increased rapidly at ambient temperature when compared to Cold storage (<10 °C) and at 37°C. In the wheat flour stored at<10 °Cand at 37°C as there was decrease in the enzymatic acidity the moisture and acidity got controlled. The gluten content of wheat flour increased in all the three temperatures at ambient, Cold storage (<10 °C) and at 37°C. At 37°C the gluten increase is more when compared to ambient, <10 °C because as temperature is increased there will be increase in the gluten formation. Moisture is the parameter that contributes to the oxidative degradation of lipids of wheat flour, as wheat flour consist of germ oil.This ultimately results in the rancidity of wheat flour. It also increases the content of free fatty acids of wheat flour, Hence Both moisture and acidity of wheat flour are directly proportional to each other.

FUTURE PROSPECTS

The future prospect of the study includes fortification of wheat flour by various antioxidant rich ingredients which increases the storage life of wheat flours. Usage of different types of packaging materials like refumigated packaging materials for flour packaging. Shelf life of the wheat flour can also be extended by using radiation technology (using low dose of gamma radiations).

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