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Research Article

The Effect of Fermentation on The Nutritional Quality and The Shelf-Life Stability 0f Fourteen Different "ACHA" (Digitaria Exilis) Varieties

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Abstract

The study focused on the effect of fermentation on fourteen different Acha grain varieties used to produce fermented starch and non-fermented grain flour. The nutritional compositions were studied using standard methods of analysis. The results revealed that fermentation improves protein values of all Acha types significantly between 2-4%. The protein values range from 11.95% to 13.96% for the fermented starch and 7.79% to 11.56% in the non-fermented grain flour respectively. The shelf-life study after four and six weeks for the products that was carried out shows that, four weeks storage provides the highest stable shelf-life conditions. Therefore, all the varieties can be processed and kept for four (4) weeks and still enjoy the nutritional value. Based on this study, fermentation could be used to improve the nutritional content of Acha grain product.

Keywords: proximate analysis, Protein values, Storage condition.

Introduction

Acha (*Digitaria exilis*) is nutritionally very important in West Africa particularly in Nigeria where many people consume the grain either once or twice daily, preferring it to other cereals [1,2] reported that the grain is rich in methionine and cysteine, amino acids vital to human health and deficient in today's major cereals: wheat, rice, maize, sorghum, barley and rye. The low carbohydrate content of *digitaria exilis* has made it to be a complement in diabetes diets, [3] reported that supplementing diets with Acha products would lead to lowering of cholesterol levels, strengthening of the immune system as well as acting as food roughages which aid the digestive system. It is also a good calories and digestible proteins for many people living and depending largely on maize, sorghum and millet grains.

Food fermentation is an enzyme-induced chemical alteration in foods, the enzymes are being produced by the microorganisms or the enzymes that are indigenously present in the food. Food fermentation is hence, the art and science of breeding microorganisms and setting them to work in foods beneficially [4]. In the process of fermentation beneficial microorganisms beat out the kind that can kill you and eat up the carbohydrates in the food. The results are interesting taste, textures and aroma that makes them palatable for consumption. Lactic acid bacteria and yeast are responsible for most of these fermentations [5].

Most pathogenic microorganisms found in food cannot survive the low pH hence lactic acid fermentation of food has been found to reduce the risk of having pathogenic microorganisms grown in the food [6]. Fermentation of food therefore have a lot of benefits which include general improvement in the shelf life, texture, taste and aroma, nutritional value and the lowering of the content of anti – nutrients of cereal products. It also plays a unique role in promoting industrial development in the nation [7].

This study is therefore aimed at evaluating the effect of fermentation on the nutritional quality of fermented starch

and non-fermented Acha grain flour of different Acha varieties and to also observe the shelf-life of the products.

Materials and Method

Source of raw material

Fourteen different varieties of Acha grain were obtained from the producers directly in the study area. The collection was as follows: - four (4) from Barkin Ladi, three (3) from Bogoro, two (2) in Bokkos and then five (5) varieties in Mangu Local Governments of Bauchi and Plateau States, Nigeria.

Preparation of material

The Acha grains were washed thoroughly with water using two local calabashes to remove sand by the sedimentation method. For the non-fermented flour, the washed grain was drained very well and dried at 500^0C (using APV Cabinet Machine dryer). The dried grains were milled (using attrition machine) and the flour sieved through a 400UM mesh screen to give a uniform particle size [8,9].While for the fermented starch, the washed grains were steeped in cold water for 6hours.The steeping water was decanted and grains were wet milled using wet grinding machine and filtered using muslin cloth, which was then covered and allowed to stay for 48-72 hours with change of water at interval. During this period fermentation proceeds, [9,10]. The settled fermented starch water was then drained using muslin cloth and allowed to dry to have the dry fermented Acha starch.

Chemical Analyses

The fermented starch and the non-fermented flour from the fourteen different varieties of Acha grains were subjected to proximate analysis. The method outlined by [11,12] were used. The parameters analysed were moisture, protein, fat, ash, fibre, calcium and phosphorus. While for carbohydrate the percentage was obtained by simple differences.

Shelf life stability study

The fourteen processed Acha products of the fermented starch and the non-fermented grain flour were all tied in separate polythene bags and kept at room temperature for the period of four (4) and Six (6) weeks, to study the shelf life stability. After the period of 4 and 6 weeks proximate analysis was carried out on all the varieties.

Results and Discussion

Proximate Composition of the Samples

The result of the proximate analysis for the non-fermented grain flour in Table 1, shows variation in all the parameters between the different Acha types, where the minimum and maximum protein and calcium values recorded in the study were found to be higher than the values reported by [13,14,15,16]; whereas the fat and carbohydrate values were only above the minimum while fibre, ash and phosphorus lies within and below the minimum values. The variations noticed could be attributed to the different varieties of the grain involved, the amino acids contents and environmental influences [17].

As the protein and fat values increases significantly during fermentation in all the Acha types Table 2, the carbohydrates values decrease. This agrees with the report of [18,19], that says carbohydrates, particularly starch and soluble sugar are principal substrates for lactic acid bacteria. Hence the primary food products are being modified through hydrolysis and a subsequent decrease in the starch content are expected to occur during natural fermentation of cereal. Also [7,20] reported that lactic acid bacteria fermentation has been shown to improve the nutritional value of foods by producing minerals, amino acids and protein anti-microbial agents.

It is therefore, clear from the result that fermented starch product from all the Acha varieties are more nutritious than the non-fermented grain flour, since they provide appreciable level of recommended dietary allowance (RDA) with respect to protein (10-12%) as recommended by World Health Organisation [21] and (10-35%) Australian Food and Grocery Council [22] for children and adult. This is because the quality of protein food is judged by its protein content and the degree to which its protein is digested and absorbed by the body [23].

S/N	SAMPLE	MOISTURE (%)	CRUDE FIBRE (%)	CRUDE PROTEIN (%)	CRUDE FAT (%)	ASH (%)	Carbohyd rate (%)	CALCIUM (g)	PHOSPHO RUS(g)
1	BD	3.95	0.30	8.85	3.60	0.55	82.75	0.215	0.031
2	WS	5.75	0.30	10.16	3.85	0.75	79.19	0.250	0.035
3	WR	6.20	0.29	9.50	2.40	0.55	81.06	0.300	0.024
4	CR	5.70	0.20	9.98	1.75	0.50	81.87	0.275	0.033
5	CK	4.30	1.30	8.54	2.60	0.40	82.86	0.175	0.020
6	WD	5.35	1.60	11.56	2.00	0.80	78.69	0.175	0.014
7	CF	3.00	0.20	8.19	1.10	0.40	87.11	0.175	0.010
8	AR	3.75	0.30	7.79	2.25	0.25	85.66	0.150	0.016
9	JM	4.00	0.70	9.15	1.85	0.30	84.00	0.150	0.016
10	ZR	5.60	1.10	10.95	2.95	0.40	79.00	0.130	0.020

11	NB	5.75	1.40	9.64	3.20	0.50	79.51	0.120	0.010
12	NH	5.65	1.70	9.20	2.35	0.30	80.80	0.110	0.020
13	KR	5.90	1.40	10.07	2.40	0.25	79.98	0.080	0.021
14	SN	5.70	1.40	10.10	2.45	0.36	79.99	0.070	0.020

Key:

BD=Badama CK=Chidt Kusun/Kukwom JM=Jakalak/Mara
WS=Whey Swello WD=Wandat ZR=Zor
WR=Whey Rwey CF=Chidt Fyali/Kall NB=Nhibang
CR=Chin Ryey AR=Chikaraya NH=Nhin
KR=Kurep SN=Sun

Table 1: Proximate Composition of the non – fermented flour samples.

S/N	SAMPLE	MOISTURE (%)	CRUDE FIBRE (%)	CRUDE PROTEIN (%)	CRUDE FAT (%)	ASH (%)	Carbohydrate (%)	CALCIUM (g)	PHOSPHORUS (g)
1	FBD	6.30	1.55	11.51	4.25	0.20	76.19	0.200	0.006
2	FWS	6.01	1.45	12.44	4.10	0.30	75.70	0.175	0.010
3	FWR	5.45	1.15	12.13	3.95	0.40	76.92	0.250	0.006
4	FCR	5.35	0.40	11.95	2.45	0.25	79.60	0.225	0.014
5	FCK	4.45	2.20	12.61	3.60	0.50	76.64	0.200	0.010
6	FWD	4.60	3.70	12.57	2.00	0.25	76.88	0.200	0.016
7	FCF	4.50	2.30	12.17	1.55	0.25	79.23	0.150	0.010
8	FAR	6.10	2.90	12.74	2.90	0.25	75.11	0.150	0.010
9	FJM	6.30	3.00	11.56	2.95	0.25	75.94	0.150	0.010
10	FZR	5.02	1.41	12.83	4.51	0.44	75.79	0.182	0.012
11	FNB	5.32	1.13	13.21	5.92	0.41	74.01	0.195	0.014
12	FNH	6.10	1.19	13.33	4.08	0.49	74.81	0.212	0.009
13	FKR	5.44	1.46	13.96	4.79	0.37	73.74	0.180	0.014
14	FSN	5.32	1.51	13.64	5.31	0.48	73.98	0.215	0.035

Key:

FBD- Fermented Badama FCR- Fermented Chin ryey FCF- Fermented Chidt fyali/kall
FAR- Fermented Chikaraya FSN- Fermented Sun FWS- Fermented Whey swello
FNB- Fermented Nhibang FNH- Fermented Nhin FJM- Fermented Jakalak/mara
FWD- Fermented Wandat FKR- Fermented kurep FWR- Fermented Whey rwey
FZR- Fermented zor FCK- Fermented Chidt kusun/Kukwom

Table 2: Proximate Composition of the Fermented Acha Starch.

In comparing the proximate composition of the Acha products, the values were subjected to two-way Anova and SPSS analysis. The result reveals that fermentation has significant effect on all the values of protein and carbohydrate, table 1 and 2 respectively. In the case of protein even those samples with lower values in the non-fermented condition, turn out to compete with those having higher values during fermentation, samples like AR and CK. While for carbohydrate there was decrease in all the values. The same increase was noticed in fat values, with the exception of only one, that is WD which has the same fat content in both samples.

The increase in the values of fibre was not in all Acha-types but was found in the majority. While for moisture, ash and calcium, the effect was seen in only few of the samples. In the case of phosphorus, the values were not being affected by fermentation in almost all the samples with the exception of only three, that is WD, NB and SN, which shows little rise in their values, table 1 and 2 respectively.

The variation seen in all the parameters between the different Acha-types is a reflection of the difference in their nutritional content, agronomic and genetic factors as reported by [17].

Shelf-life Stability

The result of the shelf-life study of the products reveals that four (4) weeks provides the highest stable shelf-life as there was no variation between the initial and the stored samples after four weeks. As such the stored samples of the six (6) weeks were considered because the

changes were noticed in them for products, Table 3 and 4. Therefore the fourteen different Acha-types can be processed into dry fermented starch and non-fermented flour form and kept for the period of four weeks and still derive the nutritional benefits of the grain. Research is in progress to isolate and identify the micro-organisms present in these Acha products.

The changes seen in all the parameters after the storage could be attributed to the long period of days, they were kept. This agrees with the report of [24], which says food products kept for a long time may experience, the oxidation of food constituents, enzymatic changes and the breakdown of the product or synthesis of new compounds, which can spoil food. Another reason could be the difference in the varieties and their genetic factors.

S/NO	Sample	Moist	Crude	Crude Fibre	Crude Protein	Ash Fat	Carbo Calcium hydrate	Phosphorus
1. BD	5.34	2.10	8.10	3.40	0.55	80.51	0.200	0.031
2. WS	6.01	2.20	9.35	3.65	0.75	78.04	0.250	0.035
3. WR	6.18	2.30	9.00	2.15	0.55	79.82	0.300	0.024
4. CR	5.97	1.80	9.05	1.25	0.50	81.43	0.275	0.033
5. CK	5.08	2.50	8.05	2.45	0.40	81.51	0.175	0.027
6. WD	5.00	2.20	10.50	1.10	0.35	80.85	0.175	0.015
7. CF	4.68	2.80	8.00	1.08	0.35	83.09	0.200	0.012
8. AR	4.99	2.70	7.25	2.10	0.25	82.71	0.175	0.016
9. JM	5.08	2.30	9.00	1.70	0.25	81.67	0.175	0.021
10. ZR	6.15	1.50	10.05	2.28	0.29	79.73	0.182	0.012
11. NB	6.32	1.61	9.10	3.03	0.33	79.61	0.195	0.014
12. NH	6.10	1.42	9.00	2.15	0.20	81.13	0.212	0.009
13. KR	6.83	1.53	9.50	2.30	0.23	79.61	0.180	0.014
14. NSN	6.76	1.59	9.48	2.15	0.22	79.80	0.215	0.035

Key:

BD=Badama CK=Chidt Kusun/Kukwom JM=Jakalak/Mara
WS=Whey Swello WD=Wandat ZR=Zor
WR=Whey Rwey CF=Chidt Fyali/Kall NB=Nhibang
CR=Chin Ryey AR=Chikaraya NH=Nhin
KR=Kurep SN=Sun

Table 3: Proximate Composition of Stored non - Fermented Acha Grain Flour after Six Weeks

S/NO	Sample	Moist	Crude	Crude Fibre	Crude Protein	Ash Fat	Carbo Calcium hydrate	Phosphorus
1. FBD	7.01	2.40	11.44	3.12	0.60	75.42	0.202	0.006
2. FWS	6.30	2.10	12.00	3.45	0.80	75.35	0.275	0.010
3. FWR	6.67	3.60	11.15	2.85	0.75	74.98	0.320	0.006
4. FCR	6.83	2.20	11.00	2.90	0.75	76.32	0.285	0.014
5. FCK	5.21	2.40	11.25	2.02	0.60	78.52	0.176	0.019
6. FWD	5.31	2.70	11.35	2.80	0.45	77.39	0.180	0.021
7. FCF	5.69	2.80	11.15	2.65	0.40	77.31	0.237	0.008
8. FAR	6.31	2.00	10.20	2.15	0.30	79.04	0.180	0.019
9. FSM	7.37	3.80	10.30	2.05	0.35	76.13	0.180	0.017
10. FZR	6.02	2.70	11.90	3.51	0.44	75.43	0.220	0.032
11. FNB	5.91	2.54	11.40	3.92	0.41	75.82	0.216	0.026
12. FNH	6.94	2.35	11.33	3.08	0.49	75.81	0.221	0.038
13. FKR	6.44	2.46	11.96	3.79	0.37	74.98	0.210	0.013
14. FSN	6.32	3.00	12.00	3.31	0.48	74.89	0.225	0.029

Key:

FBD- Fermented Badama FCR- Fermented Chin ryey FCF- Fermented Chidt fyali/kall
FAR- Fermented Chikaraya FSN- Fermented Sun FWS- Fermented Whey swello
FNB- Fermented Nhibang FNH- Fermented Nhin FJM- Fermented Jakalak/mara
FWD- Fermented Wandat FKR- Fermented kurep FWR- Fermented Whey rwey
FZR- Fermented zor FCK- Fermented Chidtkusun/Kukum

Table 4: Proximate Composition of stored Fermented Acha Starch after Six Weeks.

Conclusion

The study revealed the suitability of Acha in fermented starch and non-fermented grain flour form, in which fermentation plays an important role in enhancing the nutritional value of the product. It also shows that the shelf-life of the processed products can stay for the period of four weeks and still enjoy the nutritional value.

If the full potential of Acha is explored especially the fermented products, it will reduce the overdependence of Nigerians on imported wheat which has eaten deep into the country's economy, the utilization of Acha grain products would also improve the economic status of the producers.

Recommendation

- Adequate information on the effect of fermentation on the nutritional value and health benefits derived from Acha grain products should be given good publicity by nutritionist and the food industries.
- Awareness should be created by nutritionists and the food industry on the use of Acha to produce fermented starch and non-fermented grain flour like any other cereals (Maize, Sorghum and Millet).
- There is need for a deliberate effort by the government, private sectors and food industry to work towards developing a large-scale factory production facility for the locally fermented foods, where the quality of finished product will be assured.

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