3.8 Flatulent Factors Anlysis

Flatulence causing oligosaccharides (mainly stachyose and raffinose) were extracted by the method used by Borejszo and Khan, (1992) as modified by Onyenekwe*et al*., (1999) and separated by TLC using the method described by De Stefanis and Ponte (1968) as modified by Onyenekwe*et al*., (1999). The spots were detected and quantified according to Stahl and Kaltenbach (1992).

4. Results and Discussion

The table 1 shows the proximate composition of raw and fermented *Vignaungulculata* flour. It was observed that the protein content increased by more than 20% due to the two types of fermentation, while the lipid, ash, moisture, fiber and carbohydrate were decreasing.The increase in protein content could be due to the increase in the biomass brought about by the fermenting microorganisms. It has also been shown that the increase in the protein susceptibility to proteolytic enzymes is due to partial protein denaturaion and pH decrease during fermentation (CZarneka*et al*; 1998). The lipid, carbohydrate, fibre, ash and moisture content suffered from decrease during the open and controlled fermentation which is consistent with earlier workers (Martin-cabrejas*et al*, 2004, Granito*et al*, 2002). The reduction in these parameters is due to the metabolism of the microorganisms in the fermentation medium.

The Table 2 shows that phytate, tannin, lectins, saponins, hydrogen cyanide, trypsin inhibitors and oxalate were all reduced by the two types of fermentation. The reduction of these complex and toxic molecules was attributed to degradation by microorganisms (Madeira *et al*., 2011).

The higher percentages of reduction observed in controlled fermentation was attributed to the fact that the presence of more than one microorganism in open fermentation might have resulted in competition. An undesired microorganism is often the faster growing species and consumes the fermentation media components but does not give the desired product.

The mineral elements evaluated in the present study (Fe, Ca, Na, Zn, K, Mg) were all reduced by the two types of fermentation (table 3). Irrespective of leaching in fermentation water, mineral utilization could be taken place by microorganisms responsible of the 48 hours fermentation (Zamora and Fields, 1979) as well as reduction in ash content and minerals by leaching in soaking or cooking water (Kazamas and Fields, 1981). The reduction in the mineral content during fermentation could also be attributed to the effect of concentration due to the increase in biomass.

The level of raffanose and stachyose was reduced by the two types of fermentation. Open fermentation reduced raffinose more than controlled fermentation did, while stachyose level was more reduced by controlled fermentation than open fermentation (Table 4). Since these oligosaccharides are fermented by intestinal bacteria (Granito*et al*; 2001), the present finding is of great interest, suggesting a simple method like open fermentation in order to reduce flatulence-causing factors.

5. Conclusion

In conclusion, fermentation is an efficient method for reducing (detoxifying) tannins, phytates, alkaloids, saponins, hydrogen cyanide, trypsin inhibitors, lectins and oxalate in cowpeas. The present research work has shown that controlled fermentation using *Aspergillusniger*as a starter is more efficient in detoxifying the above mentioned antinutrients in the domesticated beans studied here compared to open fermentation.

6. Future Scope

Although the fermentation techniques used in this study have shown considerable reduction on the antinutrient levels, there is still need for further studies on the effect of fermentation on other antinutrients not studied. Moreover other processing as well as other types of fermentation methods need to be employed on other domesticated and wild beans (such as *Vignaunguiculata* and *Vignaracemosa* species) in order to further study the effect of processing on the level of reduction of antinutrients. Also the researcher encourages other researchers in the field of agriculture to carry out investigations on the cultivation of these species of bean in arid regions of the world and most especially in the savannah part of Africa since he discovered that the plant does not produce seeds when planted in the northern part of Nigeria and Cameroon.

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Table 1: The Effect of Open and Controlled Fermentation on Proximate Composition of*Phaseolus vulgaris**

Processing methods	*%Protein*	*%Lipid*	*%Moisture*	*%Ash*	*%Fibre*	*%Carbohydrate*
Raw	27.75±0.30	7.63±0.16	3.29±0.067	3.38±0.055	3.2±0.058	54.75±0.43
Open Fermented (OF)	33.05± 0.97	6.003±0.28	2.58±0.034	3.08±0.049	2.9±0.029	52.3±1.17
%Change due to OF**	19.07± 2.37↑	21.40±2.02↓	21.66±0.65↓	9.06±0.50↓	9.33±1.44↓	4.49±1.44↓
Controlled Fermented (CF)	30.48±0.22	2.53±0.018	5.66±0.047	2.65±0.018	3.08±0.044	55.59±0.13
%Change due to CF**	9.86±0.81↑	66.77±0.78↓	72.12±2.07↑	21.73±1.54↓	3.63±0.46↓	1.55±0.55↑

Table 2: The Effect of Open and Controlled Fermentation on Antinutritional factors of *Phaseolus vulgaris**

Processing Methods	*%Phytate*	*%Tannin*	*%Alkaloids*	*%Saponin*	*Hydrogen Cyanide (mg/100g)*	*%Lectines*	*Trypsin inhibitors (TIU/g)*	*%Oxalate*
Raw	0.233± 0.0033	0.124± 8.82E -05	1.31± 0.026	0.433± 0.033	0.04± 0.00058	2.33± 0.033	1.07± 0.0059	5.75E -08± 5.77E -11
Open Fermented (OF)	0.139± 0.001	0.104± 0.00056	1.023± 0.0088	0.223± 0.023	0.029± 0.00058	1.83± 0.037	0.077± 0.0050	1.58E -08± 3.33E -11
%Change due to OF**	40.39± 1.26↓	16.15± 0.50↓	21.84± 1.13↓	48.67± 1.33↓	27.49± 1.28↓	21.73± 0.51↓	92.77± 0.46↓	72.58± 0.083↓
Controlled Fermented (CF)	0.0603± 0.00012	0.0044± 0.0001	0.85± 0.029	0.000187± 8.82E -06	0.0024± 0.00012	0.00012± 8.82E -06	0.0024± 0.00015	5.8E -09± 0.000
%Change due to CF**	74.16± 0.38↓	96.46± 0.083↓	35.09± 2.17↓	99.96± 0.0050↓	93.99± 0.38↓	99.99± 0.00038↓	99.78± 0.013↓	89.91± 0.010↓

Table 3: The Effect of Open and Controlled Fermentation on the Mineral content of *Phaseolus vulgaris**

Processing Methods	*Fe (ppm)*	*Ca (ppm)*	*Na (ppm)*	*Zn (ppm)*	*Mg (ppm)*	*K (ppm)*
Raw	2.488± 0.0018	370.407± 0.012	8.99± 0.0058	0.819± 0.00058	22.36± 0.0088	132.32± 0.012
Open Fermented (OF)	1.856± 0.0037	10.647± 0.0015	4.85± 0.023	0.435± 0.0012	17.68± 0.0058	66.08± 0.012
%Change due to OF**	25.398± 0.160↓	97.126± 0.00043↓	46.05± 0.24↓	46.89± 0.18↓	20.94± 0.057↓	50.06± 0.012↓
Controlled Fermented (CF)	1.31± 0.021	16.960± 0.0018	3.60± 0.0012	0.424± 0.0023	21.61± 0.0015	19.53± 0.017
%Change due to CF**	47.35± 0.840↓	95.421± 0.00033↓	59.95± 0.019↓	48.19± 0.32↓	3.38± 0.045↓	85.24± 0.014↓

*: Values are means ± standard error of the mean for triplicate samples; E: means time ten raised to power.
**: ↓ means percentage decrease; ↑ means percentage increase

Table 4: Effect of Open and Controlled Fermentation on Some flatulent factors of *Phaseolus vulgaris**

Processing methods	*Raffinose (g/100g)*	*Stachyose (g/100g)*
Raw	5.74± 0.36	9.692± 0.68
Open Fermented (OF)	0.152± 0.014	4.21± 0.24
%Change due to OF**	97.32± 0.38↓	56.45± 1.44↓
Controlled Fermented (CF)	1.062± 0.030	0.410± 0.017
%Change due to CF**	81.30±1.61↓	95.71± 0.43↓

*: Values are means ± standard error of the mean for triplicate samples; E: means time ten raised to power.
**: ↓ means percentage decrease; ↑ means percentage increase

Figure 1: Phaseolus vulgaris seeds