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Proximate composition and acceptability of *Bunyi youri*: A traditional Nigerian fermented solar tent dried fish condiment

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ABSTRACT

In this study, fish were fermented for 24 h and then dried adopting improved methods, namely: Use of glucose to reduce fermentation time, clove for its bactericidal effect and solar tent drier for enhanced drying. The results obtained indicate a significant decrease (P≤0.05) in the moisture content and a significant increase (P≤0.05) in protein, fat, and ash contents of the processed products when compared with the fresh fish sample. An inverse relationship was also observed between the moisture content and the concentration of other nutrients. Treated samples varied significantly (P≤0.05) in their protein contents from that of the control; whereas no significant difference (P≥0.05) was recorded between the control samples and those treated with a combination of 2 and 0.6% glucose and clove, respectively. In all cases the value ranged from 60.51±1.85 and 63.69±0.31%, the ash content of the treated samples showed significant increase (P≤0.05) when compared with the commercial and laboratory controls. There was no significant difference (P≥0.05) in the carbohydrate content of the controls and the treated samples when compared with the fresh fish sample. Also, there was a significant difference (P≤0.05) in the energy values recorded from the controls and the fresh fish sample [(443.81±1.74 to 444.59±7.43 and 86.57±1.96) Kcal/100 g respectively]. The energy values for all the treated samples showed significant differences (P≤0.05) with those of the controls and the fresh sample. This value ranged between 447.38±1.84 and 455.78±6.10 Kcal/100 g for the treated samples. It was concluded that a highly nutritious and acceptable *Bunyi youri* could be produced from Nile perch when treated with a combination of 2% glucose and 0.6% clove concentrations.

INTRODUCTION

In Nigeria, fish constitutes about 60% of animal protein intake (Adeniyi, 1987). This means that shortfall in fish availability will affect the animal protein intake of people in this country. Fish also supplies employment opportunities to many rural dwellers. Furthermore, well processed fish from the tropics have a ready market in developed countries and are thus good foreign exchange earners (Eyo, 2001). The shortfall in fish supply in the country had led to a low annual per capita fish consumption rate of only 7.5 Kg as against 15 Kg per annum as recommended by the FAO (Adewuyi et al., 2010). There are various reasons for the merits of eating fish. One of such reason is that fish is less tough and more digestible compared to beef, mutton, chicken and bush meat. This is possible because of the greater ratio of muscle protein

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to connective tissue protein in fish in relation to other animals (Alais and Linden, 1999) thus making fish acceptable to infants and adult alike (Eyo, 2001). Because of its greater digestibility, fish is usually recommended to patients with digestive disorders such as ulcers (Eyo, 2001).

Most of the fish harvested in the tropic is used for direct human consumption but a great deal is processed into fish meal for use in compounding feeds. A significant quantity is also lost through the absence of adequate technology to prevent post harvest losses in most tropical countries. An estimated 20 to 50% of the fish produced in the remote coastal centers and hinterlands of many tropical countries perish before they get to the consumers due to poor handling, preservation and processing practices adopted by the artisanal fishermen, fish farmers and fisheries entrepreneurs (Negbenebor, 1990; Eyo, 2001). Therefore curing in a primeval way is still the principal method of fish processing, that is, sun drying without salt, dry as well as wet salting and fermenting are common methods of fish curing (Onaheid et al., 2012). Much of this spoilage could be reduced if such fish are traditionally processed to products that will have extended shelf life such as *Bunyi youri*. It is a putrefied sun dried fish product prepared form Nile perch (*Lates niloticus*) or *Clarias* species and is used as condiment in the flavouring of soups particularly among the Kanuri tribe of North Eastern Nigeria (Negbenebor et al., 1995). In traditional *Bunyi youri* production, the fish is scaled, gutted, washed and left to ferment for 6 to 8 days at ambient temperature (31 to 49°C). Though fish fermentation is not common and really appreciated in Nigeria, the benefit inherent in the consumption of this product will be enormous, more especially in salvaging the fish farmers and marketers from post-harvest losses.

The objective of this work is to improve the utilization of unconventional fish species through fermentation for human consumption and to determine the proximate composition and acceptability of the product.

MATERIALS AND METHODS

Sources of materials

Fresh fish samples of Nile perch (*Lates niloticus)* species were purchased directly from River Benue fish market, Yola Adamawa State. Samples were collected using clean plastic containers (size 80 × 20 × 45 cm) fitted with tight lids and packed with crushed ice to minimize deterioration of the fish during transportation to the laboratory in Maiduguri. Also, for the purpose of comparison, similar samples were taken to a local processor in Gamboru ward, in Maiduguri for *Bunyi youri* to be produced using the normal traditional method, the product served as the control sample.

Cloves (*Eugenia carryophyllata*) were obtained from Maiduguri Monday Market. Glucose of analytical grade (BDH Chemicals Ltd, U.K.) used in the fermentation process, was obtained from the Food Science and Technology Laboratory, University of Maiduguri.

Preparation of fish samples

The fresh fish samples were cut open longitudinally from one side through the ventral surface. The fish was gutted and thoroughly washed with potable water. Five treatments were used in each experimental processing. For each of the five treatments, three replicates were used. The prepared fish was divided into five different groups and four groups were treated separately with 2.0% glucose plus 0.1, 0.3, 0.5 and 0.6% of clove respectively by dipping the fish samples into the glucose-clove solution for 20 min and the fifth group which served as the Laboratory control was treated by dipping it only in distilled water. A 2.0% glucose solution was utilized for the fermentation because in a similar study, Adams et al. (1987) observed that this concentration gave the optimum fermentation and fast reduction in pH during the fermentation of a glucose-fish-cassava mixture. The prepared samples were allowed to ferment for 24 h at mean ambient temperature and relative humidity (RH) of 38.5±1.7°C and 25.9±2.1%, respectively (Adams et al., 1987).

Sequence of operation in *Bunyi youri* processing

The traditional method of *Bunyi youri* processing was utilized with modifications by including the dipping of the fish samples in mixtures of glucose and clove for 20 min prior to fermentation for 12-24 h and drying in a solar tent drier instead of the usual traditional practice of spreading on mats and direct exposure to the sun. The drying was continued for two to five days until the *Bunyi youri* was crispy-dried. The clove samples were ground using a hammer mill, wrapped in aluminum foil and then autoclaved at a temperature of 121°C and pressure of 15 psi for 15 min, to ensure its freedom from mould and bacterial spores before its application to the fish samples.

Drying process

Firstly, the drier (solar tent) was pre-heated to the desired temperature of 45°C by exposing it directly to the heat of the sun for about 30 min to ensure uniform heating of the chamber before the fish samples were placed in it. Secondly, the fermented fish samples were hung on ropes tied across the inside of the solar tent drier, and then allowed to dry at the mean temperature and relative

Table 1. Effect of glucose and clove on the proximate composition and calories of *Bunyi youri*.

Treatment	Moisture (%)*	Protein (%)*	Fat (%)*	Ash (%)*	Carbohydrate (%)*	Energy (Kcal)/100 g*
Fresh Fish	77.55±0.53^{a}	19.03±0.05^{c}	0.40±0.05^{c}	1.30±0.10^{d}	1.72±1.15^{a}	86.57±1.96^{c}
Control 1	12.65±0.96^{b}	60.63± 0.67^{b}	21.78± 1.34^{b}	2.76±0.27^{bc}	1.52±0.73^{a}	444.59±7.43^{b}
Control 2	13.56±0.16^{b}	60.54±0.48^{b}	21.69±0.10^{ab}	2.22±0.59^{cd}	1.61±0.39^{a}	443.81±1.74^{b}
A	10.26±0.71^{cd}	63.44±0.74^{a}	21.18±0.40^{b}	3.80±0.53^{ab}	1.33±0.21^{a}	449.67±4.92^{ab}
B	9.90±0.46^{cd}	63.69±0.31^{a}	21.11±0.30^{b}	3.84±0.18^{a}	1.46±0.09^{a}	450.57± 3.58^{ab}
C	9.56±1.26^{d}	63.13± 2.69^{a}	21.94± 1.10^{ab}	3.92± 1.03^{ab}	1.44± 0.15^{a}	455.78±6.10^{a}
D	11.42± 1.28^{c}	60.51± 1.85^{b}	21.94± 0.58^{ab}	4.46± 1.21^{a}	1.66± 0.81^{a}	447.38±1.84^{ab}

*Values are Mean ± standard deviation of triplicate determinations. Means followed by the same superscript within the same column are not significantly different (P≤0.05).
Control 1=Commercial *Bunyi youri*; Control 2=Laboratory prepared *Bunyi youri*; A=2% glucose+0.1% clove; B=2% glucose+0.3% clove; C=2% glucose+0.5% clove; D=2% glucose+0.6% clove.

humidity (RH) of 65.0±5.2°C and 21.9±0.35%, respectively, for two to three days–until the samples were crisp-dried. The drier was positioned downwind to allow maximum amount of air passage into the tent, since the drying process is achieved by a combination of heating and air movement (Olokor and Omojowo, 2009). The dried samples were packed in plastic containers until analyzed.

Proximate composition

The quantification of moisture, ash, lipid, crude fibre, and crude protein was carried out as described by AOAC (2000) while the "difference" method was employed for the estimation of the percentage Nitrogen free extract of each of the fish samples. The energy value was calculated as described by Merrill and Watt (1973).

Sensory evaluation

The sensory attributes of *Bunyi youri* samples were evaluated using staff and students of the Department of Food Science and Catering Studies, Ramat Polytechnic Maiduguri, who were familiar with the product quality. The dried fish were cut into pieces, cooked in boiling water for 20 min, cooled, and then serving. A 9-point hedonic scale ranging from like extremely (9) to dislike extremely (1) was used (Kremar and Twigg, (1970); samples were scored for taste, colour, texture, flavour intensity and overall acceptability. This was repeated on the 12th and 24th weeks to confirm the stability and acceptability of the products.

RESULTS AND DISCUSSION

The results of proximate composition of various *Bunyi youri* prepared in this study are shown in Table 1. The initial moisture content of fresh Nile perch was 77.55±0.53% and this is typical of Nile perch (Okeyo et al., 2009). There was a decrease in the moisture content of the processed products and a significant increase (P≤0.05) in protein, fat and ash content when compared with the fresh fish sample. This showed an inverse relationship between moisture content and the amount of other nutrients (Potter, 1986). The moisture content of the two controls showed no significance difference (P≥0.05) and is between 12.65±0.96 and 13.56±0.11% for the control 1 and 2 respectively. However, significant differences were observed (P≤0.05) for the moisture content of the treated samples which ranged between 9.56±1.26% and 11.12±1.28%. The sample treated with 2% Glu+0.5% Clo showed the lowest moisture content and the one treated with 2% Glu+0.6% showed the highest moisture content.

There was a significant difference (P≤0.05) between the protein content of the control samples and that of the treated samples except for the sample treated with 2% Glu+0.6% Clo that was not significantly different (P≥0.05) from both controls. This could have been due to inhibition of microbial metabolism which decreased the synthesis of proteins from metabolic intermediates during their growth cycles (Suchitra and Sanojnalini, 2012). Zaika and Kissinger (1984) also demonstrated the inhibition of microbial actions at higher concentration of clove. The significant increase in protein levels (P≤0.05) in dried *Bunyi youri* when compared with the raw fish, suggests that protein nitrogen was not lost during drying and this is in agreement with the findings of Ogbonnaya and Ibrahim (2009).

After drying, there was a significant increase in the fat contents (P≤0.05). This result indicates that the fat loss phenomenon was not so intense in dried *Bunyi youri* products. This may be attributed to the hard skin of the Nile perch which sealed up the fat within the body.

Also, there was a significant increase (P≤0.05) in

Table 2. Effect of glucose and clove on the sensory evaluation of *Bunyi youri* at zero week.

Treatment	Colour*	Taste*	Texture*	Flavour*	Overall acceptability*
Control 1	6.50±0.50^{b}	6.43±0.40^{c}	6.23±0.25^{e}	6.23±0.25^{e}	6.23±0.25^{c}
Control 2	6.50±0.87^{b}	7.10±0.36^{b}	7.10±0.17^{d}	7.17±0.29^{d}	7.17± 0.29^{d}
A	7.83±0.29^{a}	8.10±0.36^{a}	7.70±0.26^{c}	7.70±0.26^{c}	8.17± 0.29^{a}
B	7.33±0.29^{a}	7.50±0.50^{b}	7.97±0.25^{b}	7.97±0.25^{b}	7.97± 0.25^{a}
C	8.17±0.29^{a}	8.50±0.00^{a}	8.17±0.29^{a}	8.17±0.29^{a}	8.17± 0.29^{a}
D	6.50±0.50^{b}	7.33±0.29^{b}	7.10±0.17^{d}	7.10±0.17^{d}	7.10± 0.17^{b}

*Values are Mean ± standard deviation of triplicate determinations. Means followed by the same superscript within the same column are not significantly different (P≤0.05).
Control 1=Commercial *Bunyi youri*; Control 2=Laboratory prepared *Bunyi youri*; A=2% glucose+0.1% clove; B=2% glucose+0.3% clove; C=2% glucose+0.5% clove; D=2% glucose+0.6% clove.

the ash content of both controls and treated samples when compared with the fresh fish sample. The ash content of the treated samples showed significant increase (P≤0.05) when compared with the commercial and laboratory controls. This may be attributed to the contribution by the spices (Hamm, 1970).

In preliminary studies on *Bunyi youri* by Negbenebor et al. (1995), it was observed that after fermentation, there was a significant increase (P≤0.05) in the amount of protein, fat and ash in the processed *Bunyi youri* but a decrease in the amount of moisture content of the fermented product when compared with the fresh unfermented product. These authors observed that the decrease in the moisture content could have led to a concentration of the nutrients in the finished *Bunyi youri* product. However this study showed a significant (P≤0.05) increase in the nutrients when compared with the work of these authors and this could have been due to the accelerated processing which lasted for days instead of weeks.

There was no significant (P≥0.05) difference in the carbohydrate content of the controls and the treated samples when compared to the fresh fish sample. It could therefore be concluded that the microorganisms involved in fermentation, first used up the added glucose before the fish glycogen and that the added glucose was sufficient for the fermentation period and this indicated that the 2% glucose added for lactic acid bacteria fermentation was the major source of carbohydrate in this product. This is in line with the findings of Nandsha et al. (2010) in Thai traditional fermented Shrimp and Krill products.

The energy value increased significantly in the processed samples when compared with the fresh sample. Thus there was significant difference (P≤0.05) in the energy values for the controls and the fresh sample [(443.81±1.74 to 444.59±7.43 and 86.57±1.96) Kcal/100 g respectively]. The energy values for all the treated samples showed significant differences (P≤0.05) with those of the controls and the fresh sample. This value ranged between 447.38±1.84 and 455.78±6.10 Kcal/100 g for the treated samples. The increase in energy value is in agreement with the results of Tao and Linchun (2008). "Bunyi youri" however has a low energy value and this suggests that it cannot meet the daily energy requirement which is 3000 Kcal for an adult man and 2200 Kcal for an active woman (Anonymous, 1972). Therefore *Bunyi youri* is not an energetic food product and should be consumed with other energy giving foods in the diet, so as not to renders its contribution less important in the diet. This is however of advantage to those people dieting.

Tables 2, 3 and 4 show the sensory evaluation results of *Bunyi youri* stored at ambient temperature for 24 weeks and evaluated at week 0, 12 and 24, respectively. The sample treated with a combination of 2% and 0.5% glucose and clove, respective, showed significantly higher rating (P≤0.05) in sensory scores when compared with the other treatments and controls on week 0, in terms of colour, taste, texture, flavour and overall acceptability. Similarly at weeks 12 and 24, the same sample showed significantly higher rating (P≤0.05) in sensory scores when compared with the other treated samples and the controls with regards to the parameters evaluated. As the storage progressed, all the samples, irrespective of treatments, showed decreased in sensory qualities. Del Valle et al. (1984) reported a similar result on the possibility of keeping anchovies in brine at 0°C. This could be as a result of the microbial and chemical changes that must have taken place during the period of storage leading to lower quality of the product.

From week 0 to week 24, the sample treated with 2% Glu + 0.5% Clo was rated significantly better in all the parameters evaluated. This therefore suggests that this combination is the possibly acceptable treatment to *Bunyi youri* without adverse effect on the quality of the product. Daramola et al (2007) also observed a general decline in physical attributes, that is, colour, fragments or cracks, odour, taste and texture of fish during storage.

Table 3. Effect of glucose and clove on the sensory evaluation of *Bunyi youri* at 12th week.

Treatment	Colour*	Taste*	Texture*	Flavour*	Overall acceptability*
Control 1	6.20± 0.35^{b}	6.23± 0.21^{c}	5.93± 0.12^{c}	6.17± 0.29^{c}	5.57± 0.58^{e}
Control 2	6.17± 0.29^{b}	6.53± 0.31^{c}	6.57± 0.12^{b}	6.67± 0.29^{b}	6.17± 0.29^{d}
A	6.67± 0.29^{ab}	7.33± 0.29^{b}	7.37± 0.32^{a}	7.37± 0.32^{a}	7.17± 0.29^{c}
B	6.50± 0.50^{b}	7.03± 0.25^{b}	7.43± 0.40^{a}	7.43± 0.40^{a}	7.33± 0.29^{b}
C	7.17± 0.29^{a}	8.00± 0.00^{a}	7.67± 0.29^{a}	7.67± 0.29^{a}	7.50± 0.50^{a}
D	6.17± 0.29^{b}	7.00± 0.00^{b}	6.17± 0.29^{c}	6.17± 0.29^{c}	6.10± 0.36^{d}

*Values are Mean ± standard deviation of triplicate determinations. Means followed by the same superscript within the same column are not significantly different (P≤0.05).
Control 1=Commercial *Bunyi youri*; Control 2=Laboratory prepared *Bunyi youri*; A=2% glucose+0.1% clove; B=2% glucose+0.3% clove; C=2% glucose+0.5% clove; D=2% glucose+0.6% clove.

Table 4. Effect of glucose and clove on the sensory evaluation of *Bunyi youri* 24th week.

Treatment	Colour*	Taste*	Texture*	Flavour*	Overall acceptability*
Control 1	5.00±0.00^{b}	5.10±0.17^{cd}	5.33±0.29^{c}	5.00±0.00^{c}	5.00±0.00^{b}
Control 2	5.17±0.29^{b}	5.00±0.00^{d}	5.37±0.31^{c}	5.17±0.29^{bc}	5.17±0.29^{b}
A	5.17±0.29^{b}	5.50±0.00^{bc}	6.30±0.30^{b}	5.83±0.76^{ab}	6.17±0.29^{a}
B	5.17±0.29^{b}	5.67±0.29^{b}	6.10±0.36^{b}	5.83±0.76^{ab}	6.00±1.00^{a}
C	6.00±0.50^{a}	6.83±0.29^{a}	6.83±0.29^{a}	6.37±0.32^{a}	6.70±0.26^{a}
D	5.17±0.29^{b}	5.33±0.29^{bcd}	5.33±0.29^{c}	4.83±0.29^{c}	5.00±0.00^{b}

*Values are Mean ± standard deviation of triplicate determinations. Means followed by the same superscript within the same column are not significantly different (P ≤ 0.05).
Control 1=Commercial *Bunyi youri*; Control 2=Laboratory prepared *Bunyi youri*; A=2% glucose+0.1% clove; B=2% glucose+0.3% clove; C=2% glucose+0.5% clove; D=2% glucose+0.6% clove.

Conclusion

The suitability of Nile perch in preparing *Bunyi youri* using glucose and clove in Nigeria was studied under a laboratory condition; the proximate compositions as well as the sensory attribute of the processed *Bunyi youri* were evaluated using the standard methods. A high percentage decrease in weight was equally observed in all the treated samples and this could be of advantage especially during storage and transportation of the processed fish. In conclusion, this study has shown that a highly nutritious and acceptable *Bunyi youri* could be produced from Nile perch treated with a combination of 2% and 0.5% concentrations of glucose and clove, respectively. The use of glucose in the processing of *Bunyi youri* reduced the fermentation time, and the use of solar tent drier operated at a higher temperature, when compared to the ambient temperature, resulted to an accelerated process a more hygienic product. Such accelerated processing will lead to an increase in the turnover of the product and more financial benefits to the local fish processors. It will also help in increasing the protein supply which hitherto remains a serious problem in most developing countries, including Nigeria.

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REFERENCES

Adams M. R., Cooke R. D. & Twiddy D. R. (1987). Fermentation parameters involved in the production of lactic acid preserved fish-glucose substrates. Int. J. Food Sci. Tech. 22:105-114.
Adeniyi J. P. (1987). Fish consumption in Nigeria. Implications for fishery development policies. J. West Afr. Fish. 3(2):151-161.
Adewuyi S. A., Philip B. B., Ayinde I. A. & Akerele D. (2010). Analysis of profitability of fish farming in Ogun State, Nigeria. J. Hum. Ecol. 31(3):179-184.
Alais C. & Linden G. (1999). Food biochemistry, English Edition Aspen Publishers Inc. Gaitherburg.
Anonymous (1972). Physico-chemical characteristics, fatty acid composition and lipoxygenaes activity of crude pumpkin and melon seed flour. J. Agric. Food Chem. 44:964–966.
Association of Official Analytical Chemists, AOAC (2000). Official methods of analysis. 17th ed. Association of Official Analytical

Chemists. Washington DC.
Daramola J. A., Fasakin E. A. & Adeparusi E. O. (2007). Changes in physicochemical and sensory characteristics of smoke-dried fish species stored at ambient temperature. Afr. J. Food Agric. Nutr. Dev. 7(6):
Del Valle C. E., Filsinger B. E., Yeannes M. I. & Soule C. L. (1984). Shelf life of brine refrigerated Anchovies (*Engraulis anchoita*) for canning. J. Food Sci. 49:180-182.
Eyo A. A. (2001). Fish processing in the tropics. Published by National Institute for Fresh Water Fisheries Research, NIFFR, New Bussa, Nigeria, University of Ilorin Press. Pp. 403.
Hamm R. (1970). Interaction between phosphates and meat proteins, In: Symposium- Phosphates in food processing, (Ed. Mann, J.M and Melnychyn, P) 5: 65, Avi Publication Company, Wesport, CT.
Kramer A. & Twigg B. A. (1970). Quality control for the food industry. Avi. Publishing Co. Inc., Westport, Conn. Vol. 1. Pp. 120-154.
Merrill, L. A. & Watt K. B. (1973). Energy value of Foods-basis and derivation. Agricultural Handbook No. 74, United State Department of Agriculture.
Nandsha F., Soottawat B., Sutting P. & Wanwisa B. (2010). Chemical composition and antioxdative activity of Thai traditional fermented shrimp and krill products. Food Chem. 119:113-140.
Negbenebor C. A. (1990). Raw material supply for fishery and animal products processing industry. In: Strategies for agro-based industry, raw material supply, processing and sanitation. Eds. I. Nkama and P. A. Sopade. In: Proceedings of a two-day workshop by North-Eastern Chapter NIFST, University of Maiduguri, Maiduguri.
Negbenebor C. A., Kadaura S. G. & Igene J. O. (1995). Preliminary studies in the production of *Bunyi youri* (A putrified sun-dried fish production) Agrosearch. 1:25-33.
Ogbonnaya C. & Ibrahim M. S. (2009). Effects of drying methods on proximate compositions of catfish (*Clarias gariepinus*). World J. Agric. Sci. 5(1):114-116.
Okeyo G. O., Lokuruka M. N. I. & Matofari J. W. (2009). Nutritional composition and shelf-life of the Lake Victoria Nile perch (*Lates niloticus*) stored in Ice. Afr. J. Agric. Nutr. Dev. 9(3):901-919.
Olokor J. O. & Omojowo F. S. (2009). Adaptation and Improvement of a Simple Solar-Tent Drier to Enhance Fish Drying. Nature Sci. 7(10):18-24.
Onaheid A. O., Abdelmoneim E. S., Elamin A. E. & Waleid A. M. (2012). Chemical and microbiological characteristics of fermented fish product, Fassiekh. Food and Public Health. 2(6):213-218.
Potter N. N. (1986). Food science, Avi Pub. Co. Inc. Wesport, Conn.
Suchitra T. & Sarojinalini C. (2012). Effect of temperature on biochemical and Microbiological qualities of *Ngari*. Nature Sci. 10(2):32-40.
Tao W. & Linchun M. (2008). Influence of hot air drying and microwave drying on nutritional and odorous properties of grass carp (*Ctenopharngodon idellus*) fillets. Food Chem. 110(3):647-652.
Zaika L. L. & Kissinger J. C. (1984). Fermentation enhancement by spices: Identification of active component. J. Food Sci. 49:5-9.