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Assessing the Responsiveness to Demand Creation and Communication on Probiotics Use Among Fish Farmers in Akwa Ibom State, Nigeria: A 9-Parametre Path Analytic Modeling Approach

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ABSTRACT

Aquaculture industries face challenges such as poor fish growth, infertility, disease outbreaks, and water quality issues, which negatively impact productivity. As the industry continues to expand, it plays a crucial role in the food supply chain. Consumers are increasingly demanding seafood products that are environmentally sustainable, organic, and free from antibiotics and harmful chemicals. This study aims to assess how demand creation communication influences the use of probiotics among fish farmers. A multi-stage sampling technique was employed to select 180 respondents for the study. Primary data were collected through a structured questionnaire, and analysis was conducted using ANOVA. Path analysis (PLS-SEM) was used to test the hypotheses. Findings revealed that 76.9% of respondents were female, 96.8% were married, and the average age was 58.1 years. About 66.5% had secondary-level education, while 52% were traders, with an average of 34.5 years of experience in their primary occupation. Only 35.2% had moderate knowledge of probiotics, and the most common communication channel was through friends and neighbors (77.6%). A major issue identified was the lack of in-depth awareness regarding the benefits of probiotics in fish diets. Path analysis results showed that knowledge level was the primary influencing factor in probiotic adoption. To bridge this gap, it is recommended that both public and private organizations initiate probiotic education programs. Training and awareness campaigns, particularly through social media, should be implemented to enhance farmers' understanding and adoption of probiotics in aquaculture.

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INTRODUCTION

The misuse and overuse of antibiotics in commercial aquaculture accelerate the development of antibiotic resistance in both animals and humans (WHO, 1999; 2006; 2021). As the aquaculture industry expands, it plays a crucial role in the food supply chain, according to world fish 2019. Consumers increasingly demand seafood that is produced sustainably, free from antibiotics and harmful chemicals. To address this, it is essential to assess antibiotic use practices in aquaculture and develop appropriate policies, guidelines, and interventions (Tuan et al., 2013).

Studies indicate that many fish farmers rely on antibiotics for growth promotion, disease treatment, and prevention (Chowdhury et al., 2021). However, research has also found antibiotic-resistant bacteria in fish and other farm animal-derived foods, posing a significant public health risk (Siddique et al., 2021;Newaj-Fyzul and Austin 2014). A United Nations report (2017) warns that antimicrobial resistance could result in 10 million deaths annually by 2050. This growing threat necessitates alternative solutions such as probiotics, which provide a natural approach to improving fish health and productivity (Verschuere et al., 2000; Lakshmi et al., 2013).

Probiotics are live microorganisms that help maintain intestinal microbial balance. They enhance water quality, inhibit harmful pathogens, strengthen the immune system, reduce disease prevalence, promote growth, improve digestion, and support reproduction in fish (Fuller's 1974; Martin et al., 2013; Standen et al., 2013).

Recently, Lazado and Caipang (2014), proposed that probiotics under an aquaculture understanding be defined as 'live or dead, or even a component of the microorganisms that act under different modes of action in conferring beneficial effects to the host or to its environment'. This contemporary definition reflects all the advances in probiotics research in aquaculture for over three decades since its first application. Probiotics have several mechanisms in conferring their benefits to the host fish. Such a feature makes probiotic research in aquatic animals a very dynamic field. The results demonstrating the multitude of ways in delivering benefits to the host have immensely traditional understanding of probiotics as modifier of the microbial community in the host. This paper acknowledges the immense potentials of probiotics as health-promoting alternative through the identified different modes of action of probiotics following their application in aquaculture. It focuses more on how they improve the quality of the rearing environment, protect fish from biological hazards, and modulate physiological processes that eventually promote the health and welfare status of fish in culture.

They are generally considered safe, though concerns exist about their potential to alter intestinal microflora (Snydman, 2008; Ringø et al., 2010). Due to limited and sometimes conflicting research findings, more studies are needed (Verschuere et al., 2000; Moriarty et al., 2005; Nayak 2010; Mayer, 2012; Lazado and Caipang 2014).

Based on these concerns, the study seeks to answer key questions, including: What are the socioeconomic characteristics of fish farmers? What is their knowledge level of probiotics? What factors influence probiotic use? How does probiotic adoption impact farmers' well-being? What is the willingness to pay for probiotics? How do farmers respond to demand creation efforts, and what are the most effective communication pathways for promoting probiotic use?

MATERIALS AND METHODS

Study Area

The study was carryout in Akwa ibom state within the South-South geopolitical ecological zone, part of Nigeria. The state lies between latitudes 4^0 31″ and 5^0 31″ North and longitudes 7^0 35″ and $8^0$25″ East.

Population of the Study

The population of the study consists of all the registered fish farmers by Akwa ibom state Ministry of Agriculture.

Sampling Procedure and Sample Size

There are about 350 fish farmers on list of fisheries department in the ministry of agriculture. Since the 350 registered fish farmers with the Akwa ibom state ministry of Agriculture fisheries division are within the population of fish farmers who is willing to participate shall be the sample size.

Source of Data and Method of Data Collection Technique

The primary data was used for the study. A questionnaire was used to elicit information from farmers in Akwa ibom state. The content of the questionnaire comprises of open and close ended questions.

(i) Composite Index

The composite index analysis is a mathematical procedure towards normalization of non-metric and less intervals scaled generated data for a parametric statistics and meaningful interpretation. The procedure adopts the summative rating scoring of the responses of each respondent and subsequently the generated scores are normalized by the division of the scores by its maximum possible scores obtainable from a particular scale. The outcome generates an index value that ranges between 0.00 and 1.00. According to Kerlinger and Lee (2000), the index value is probabilistic or can be considered as a probability or likelihood since the value only ranges from 0 to 1. It can also be expressed in percentage if multiplied by hundred. For ease of analysis of the degree of the measurable estimates, the index distribution can be discretionally categorized into equal interval of choice depending on meaningful descriptive ability. As the measurable attribute more towards 1.00, it implies that the estimation of the proportion or amount of the construct by the respondent was very high. Otherwise, if the index estimation moves towards 0.00, it implies that the estimation of the proportion or amount of the construct by the respondent was very low.

$$\sum X_i = X_1 + X_2 + X_3 + ------ + X_n$$

$\sum X_i$ = Score of the component of measurable attributes

$$X_i = 1$$

Therefore, composite index = $\frac{\sum_{i=1}^{n} X_1}{M_s}$

Where n = number of items

X_i-------------------X_n= items of the scale of the measurable attributes

$\sum_{X_i=1}^{n}$ = Summative rating of the measurable variable

M_s = Possible maximum weighted score, which is the summation of the possible highest value of each of the scaled n items.

(ii) Path Analysis

Path analysis is among the most senior of structural equation modeling (SEM) family used in the estimation of presumed causal relationship among observed variables. The specification of path model follows a recursive model which can be in forms of either (i) graphical form (using path diagram) or (ii) structural equation. In structural equation, the direct causal effects are represented by path co-efficient or structural co-efficient. These coefficients are analogous to standardized regression coefficients, resulting from a multiple regression analysis and their interpretations are similar. The Z_i indicates the standardized raw score value on each variable. The symbol for a path coefficients is a p with two subscripts (P_{ji}), the first indicating the effect or the dependent variable and the second subscript indicating the cause or independent variables. Building the recursive path model was based on the assumptions that causal interrelationship must be examined among a set of variables that have been logically ordered on the basis of time. These assumptions were supported by Kerlinger and Lee (2002) and they are: 1. The model must accurately reflect in the actual sequence. 2. There is one way causal flow in the model. This implies that, reciprocal causation between variables is ruled out. 3. The criterion variables are measured on an interval scale. 4. The relations among variables in the model are linear, additive and causal in nature. Consequently, curvilinear, multiplicative or interaction relations are excluded. 5. The residuals are not correlated with variables preceding them in the model, nor are they correlated among themselves. 6. The structural equation for each endogenous variable includes all variables that are direct causes of that particular endogenous variable. The variables that were considered in the path analysis are as follows:

Independent Variables: Z_1 = Age, Z_3 = Education, Z_2 = Household size, Z_4 = Socio economic wellbeing. Z_5 = Use of communication media, Z_6 = Knowledge of probiotics technique use, Z_8 = Willingness to probiotics technique use

Dependent Variables: Z_9 = Responsiveness to probiotics technique use demand as shown in Figure 1.

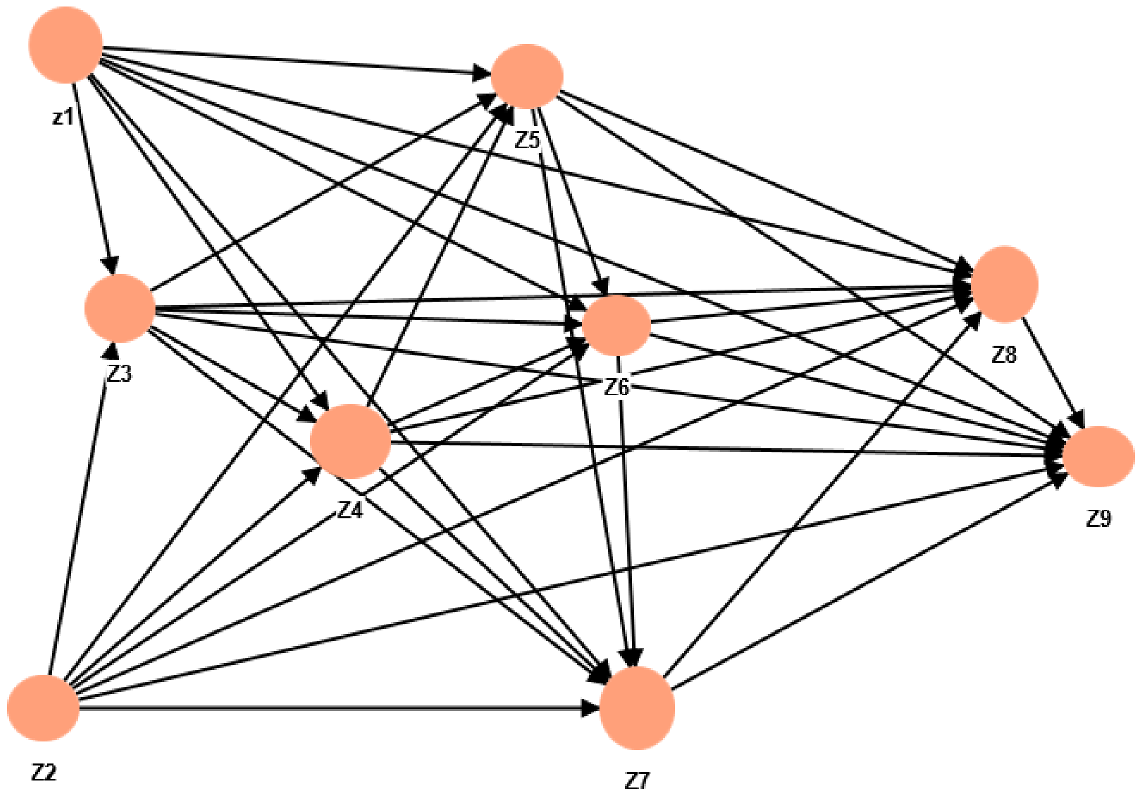

Figure 1. Hypothesized recursive path model of nine variables

RESULTS AND DISCUSSION

Level of Knowledge about Probiotics Use

To determine the level of knowledge of probiotic utilization among fish farmers in the study area, composite index analysis was used to ascertain each of the respondent's response index. The incidence index range and its implication are presented on table 1. The incidence index range within 0.251-0.5099 is described as low knowledge level with a composition of 7.8%. fairly, 14.4% of the respondents had an moderate level of awareness of probiotics benefits to farmers,27.5% of the respondents had a high level of awareness while 50.3% had virtually neglible information on the knowledge and utilization of probiotic and this is observed to be the highest, within the range of 0.00-0.2509. This result implies that there is still a gap in their knowledge level of probiotics benefits to their fish among the farmers in the study area. Hence, it is relatively from the findings that there was low use of probiotics among farmers in the study area.

Table 1. Distribution of the respondents based on level of knowledge about probiotics use

KPU Index Range	KPU Index Range interpretation	Frequency	Percent
0.00-0.2509	Virtually negligible	84	50.3
0.251-0.5099	Low	13	7.8
0.51-0.7509	Moderate	24	14.4
0.751-1.00	High	46	27.5
Total		**167**	**100.0**

Source: Field Data Survey, 2023

Ascertain Most Prevalent Communication Pathways on Demand Creation Approaches

Table 2 showed the distribution of the respondents' responses on communication channel through which fish farmers got probiotic utilization information. Generally, from the table 2, it was observed that all the communication pathways were perceived by the respondents as not utilized. This is evident by the rate of yes affirmation received by all the communication pathways which was < 50% response rate. Inspite of the above fact, it was observed according to the (RROP) which revealed that majority (38.3%) of the respondents got the information from extension agent, (35.9%) got the information from social media, (25.7%) got the information from friends and neighbor while the least channel was family members (7.8%) response rate. This implies that extension agents were the major communication pathways through was fish farmers utilizes probiotic on their fish farm.

Table 2. Distribution of respondents based on most prevalent communication pathways through which information on probiotic is utilized

Item	What are the communication pathways through which you got probiotics utilization information	No	Yes	RROP
1	Friends/ neighbors	124 (74.3)	43 (25.7)	3rd
2	Radio programmes	139 (83.2)	28 (16.8)	5th
3	Cooperative meetings	146 (87.4)	21 (12.6)	7th
4	Television	138 (82.6)	29 (17.4)	4
5	Newspaper	144 (86.2)	23 (13.8)	6
6	Pamphlets, flyers and posters	144 (86.2)	23 (13.8)	6
7	Extension workers	103 (61.7)	64 (38.3)	1
8	Family members	155 (92.2)	13 (7.8)	9
9	Posters	148 (88.6)	19 (11.4)	8
10	Social media (facebook, whatsapp, etc)	107 (64.1)	60 (35.9)	2

Level of Communication on Use of Probiotics

To determine the level of communication on the use of probiotic among fish farmers in the study area, composite index range were used to ascertain each of the respondents' response index. Table 3 it was revealed that majority representing (71.9%) shows a virtually negligible level of communication. This is followed by (22.2%) that are low in term level of communication on use of probiotic. Only (5.4%) of the respondents shows a moderate level of communication use. This implies that majority of the respondents have low and negligible level of communication which could affect utilization of probiotic.

Table 3. Distribution of respondents based on level of communication on use of probiotics

CUP Index Range	CUP Index Range interpretation	Frequency	Percent
0.00-0.2509	Virtually negligible	120	71.9
0.251-0.5099	Low	37	22.2
0.51-0.7509	Moderate	9	5.4
0.751-1.00	High	1	.6
Total		**167**	**100.0**

Source: Field Survey, 2023

Hypotheses of Study

Hypothesis One: There is no significant relationship between the respondent's level of knowledge of probiotics use and level of the responsiveness to demand creation communication on probiotics use.

The result in Table 4 shows that there is a statistically significant relationship in the respondent's level of knowledge of probiotics use and level of the responsiveness to demand creation on probiotics use because the significant value of 0.000 is less than the p-value of 0.05. This implies that the null hypothesis is rejected while the alternate hypothesis is accepted.

Table 4. Correlation between the respondent's level of knowledge of probiotics use and level of the responsiveness to demand creation communication on probiotics use

Variables	R-value	R^2	Sig. (2-tailed)	Decision at 0.05 level
Level of Knowledge about Probiotic Use Versus level of the responsiveness to demand creation communication on probiotics use	0.888		0.000	Ho rejected

Source: Field Survey, 2023.

Hypothesis Three: There is no statistically significant model that is consistent with the empirical data which describes the causal effect among age, education, socio economic wellbeing, use of communication media, knowledge of probiotic use, willingness to pay for probiotic use and responsiveness to probiotic demand creation.

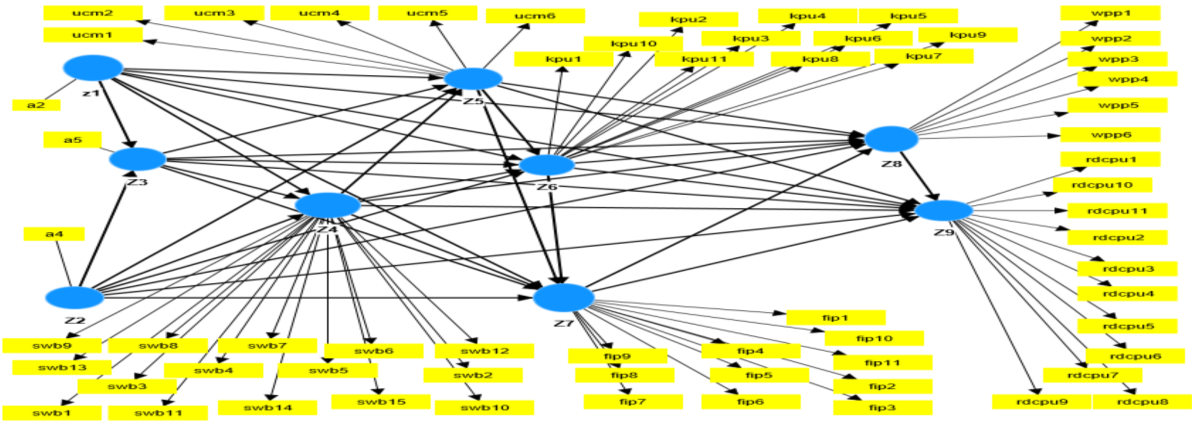

Figure 2. Evaluation of structural model

In order to assess the structural model, standard assessment criteria which according to Richter and Ringle, (2018), include the blindfolding-based cross-validated redundancy measure Q^2 or F^2 and statistical significance of the path coefficients as shown in Figure 2. The F^2 is a measure which establishes the relevance of the endogenous variables in the model. It is also called the predictive relevance of endogenous variables in a model. An endogenous variable is considered relevant to a model if F^2 value is greater than zero.

Significance of path coefficients is the certainty with which a variable establishes a causal relationship with another variable. In PLS-SEM, the significance of a path coefficient is measured using the 95% bias-corrected and accelerated (BCa) bootstrap confidence intervals. Alternatively, one may revert to the bootstrap P-values. Wuensch (2016), suggested that one may include a “meaningfulness” criterion and/or a minimum absolute value of Beta for retention.

DISCUSSION

This study evaluates the demand creation on probiotics use among fish farmers in the study area. A multi stage random sampling procedure was used to select respondents for the study. Data was collected with a well-structured questionnaire. The objectives were to; examine the knowledge level of fish farmers on the use of probiotics, ascertain the most prevalent communication pathways of the probiotics demand creation approaches in the study area, ascertain the influence to probiotics based fish by the respondents, assess the extent of their responsiveness to the probiotics based fish. Descriptive statistics, frequency count, composite and incidence index, percentage distribution, were used for data analysis. The major findings in this study are summarized as follows; majority (65.9%) of the respondents were male, (58.1%) fell on the age range 35-50 years of age, (92.3%) had highest educational qualification, majority (75.4%) of the respondents were married, (64.1%) are traders, and (47.9%) had 5-8 persons in their household. Also majority (44.9%) of the respondents have pond size of 15-200M^2, 82% had farm experience of 2-15years, 79.6% were not member of farm cooperative, while 77.25% have access to extension service. This results suggest that majority of the farmers were young within the economically active age who have some form of formal education and experience that can permit a free flow of probiotics information and improve probiotics knowledge.

The result of the knowledge level of the respondents on probiotics use indicators showed generally, that there was considerable high knowledge in some of the fish farmers in the study area. According to the respondents level of knowledge on probiotics benefits, the knowledge level index (KLI) range showed that only (50.3%) representing the majority, of the farmers in the study area had a negligible knowledge on probiotics benefits, (27.5%) had high knowledge while only (14.4%) had moderate knowledge leaving few numbers representing (7.8%) of them that had low knowledge on probiotics benefits. This result implies that there is still knowledge inadequacy on probiotics benefits among the farmers in the study area. Hence, relatively from the findings, there will be low use of probiotics among the fish farmers in the study area.

Result on the factors influencing probiotic use in the study area shows that 62.9% of the respondents were within the FIPU index range of 0.51-0.7509 which implies that respondents considered those factors as moderate for their utilization of probiotic, 21.65% were within the index range of 0.751.00, that is the factors highly influence the utilization of probiotic use by fish farmers, while 15.0% of the respondent were within the index range of 0.251-0.5099.

The result of the respondents' responses on communication channel through which they got probiotics information. It was generally observed that extension workers mean was prominent in the study area as majority (38.9%) of the respondents got the information from extension workers, (35.9%) got the information from social media, (25.7%) got the information from friends and neighbor while the least channel was family members with (7.8%) response rate. The result also revealed the level of communication on use of probiotic, which reveals that majority of the respondents (71.9%) had a negligible level of communication while 22.25 had low level of communication on probiotic use.

Result on the responsiveness to demand creation communication on probiotics use shows that majority 91.6% of fish farmers do not use probiotic in their fish production activities, 3.0% used probiotic for at least three times per week and two times per week respectively. While 1.8% used probiotic twice daily. Also, the level of responsiveness shows that the level of responsiveness of fish farmers in the study area to demand creation of probiotic use was negligible. This was evident by the majority (61.7%) of the respondents while (29.3%) of the respondents had low response to demand creation of probiotic use leaving few representing (9.0%) that had moderate response.

The analysis of the four hypothesis revealed a significant difference between selected socioeconomic characteristics and the responsiveness to demand creation communication on probiotic use and also in the respondent's level of knowledge of probiotics use and level of the responsiveness to demand creation communication on probiotics use.

The model that describes the causal effect among endogenous variables and criterion variable possesses discriminant validity but did not possess convergent validity because of the low item loading that reflects the constructs. However, the model which describes the causal effect among endogenous variables and criterion variable was consistent with the empirical data.

There are significant estimated direct effects in the causal model explaining household size, socioeconomic wellbeing, influence to probiotics, use of communication media, probiotics knowledge, willingness to feed probiotics and responsiveness to probiotics demand. Therefore, the causal direct effect on age and education were exogenous in the model.

There are significant estimated indirect effects in the causal model explaining socioeconomic wellbeing, influence to probiotics, use of communication media, probiotics knowledge, willingness to feed probiotics and responsiveness to probiotics demand. Therefore, the causal indirect effect on age, education and household size were exogenous in the model. There are significant estimated total effects in the causal model explaining household size, socioeconomic wellbeing, influence to probiotics, use of communication media, probiotics knowledge, willingness to feed probiotics and responsiveness to probiotics demand. Therefore, the causal total effect on age and education were exogenous in the model. Finally, Age, education, household size, influence, socioeconomic wellbeing, willingness, knowledge and communication pathways accounted for 28.3% of the variance observed in the responsiveness. The path coefficients from extraneous variables to the endogenous variables and criterion variable were all negligible and they exert great influence.

CONCLUSION

Demand creation, communication on probiotics use among fish farmers, specifically, seeks to develop user-first interventions for creating demand and sustaining the utilization of probiotics fish diets by the farmers. From the results of this study, it is evident that fish probiotics among farmers in study area is low. This is explained by the farmers' prevalent communication pathways through which information on probiotic is utilized and knowledge level on probiotics use benefits. Influence to probiotics (0.473) were found to have the highest significant direct effect on farmers responsiveness and this was followed by respondents' probiotics knowledge (0.233) but since the path from influence did not make any theoretical meaning, it is therefore not considered as important path. Hence, knowledge level is considered the important variable that has the highest significant direct effect on responsiveness. The indirect effect on farmers responsiveness was greatly cause by influence. The result of the PLS-SEM revealed not just the magnitude of the effects on the responsiveness by the causal variables but also, the directions of the effect. Therefore, following the paths of the effects, this study attempted to develop a demand creation approach for probiotics use among farmers.

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Conflict of Interest Statement

The authors have declared that there are no competing interests.

Authors Contribution

The authors contribute equally to the research

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