RESEARCH ARTICLE

INFLUENCE OF THE AGRO-ECOLOGICAL ZONES IN SENEGAL ON DIETARY CONSUMPTION OF PEANUT

Nar Diène[1], Papa M. Diédhiou[2] and Amadou Diop[3]

1. Department of Plant Biology, Cheikh Anta DIOP University of Dakar, BP 5005, Senegal.
2. Department of Aquaculture, Agronomic Sciences and Food Technologies, Gaston Berger University of Saint-Louis, BP 234, Senegal.
3. Department of Pharmacy, Laboratory of Analytical Chemistry and Bromatology, Faculty of Medicine and Odonto-Stomatology, BP 5005, Dakar.

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Abstract

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Peanutisa valuable source of nutrients, but the patterns of peanut consumption, consumption frequencies and factors influencing peanut consumption in Senegal are poorly understood.This study surveyed the populations of four agroecological zones of Senegal:The Peanut Basin (BA), the Lower and Middle Casamance (BMC), the Eastern Senegal and Upper Casamance (SOHC) and the Senegal River Valley (VFS) with the aim of generating data on the consumption of peanut to fill this lack of knowledge and information on this food which represents a good part of the diet of the Senegalese population. The survey sampling plan is designed according to the principles of simple random sampling (SAS) combined with prior stratification. The results of the study showed that peanut-based dishes such as Nieleng in the BA use approximately 1048g of peanut during its preparation. In the VFS, the preparation of Dakhine requires an intake of 692g of peanut. The frequency of consumption of peanut-based dishes also varies according to agro-ecological zones. In the Peanut Basin, Mafé using approximately 465.7g per dish is consumed once or twice a week as is Mbaxalu Saloum in the BMC where 222.8g of peanut are used for a prepared dish. Individual peanut consumption varies depending on the agro-ecological zones. The highest average consumption is noted in the BA with 50.57g. It is followed by the SOHC, the VFS and the BMC with respective values of 41.38g, 25.18g. and 24.73g. People headed by a man in households consume an average of 50g of peanut per day per dish and those headed by a woman, around 40g.Polygamous families consume on average 55.4g of peanut per day per peanut dish. People in families whose chef did not attend school consume on average 51.6g of peanut per dish followed by those whose chef attended Koranic school with 50.9g of peanut per dish per day.

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Corresponding Author:- Nar Diène
Address**:-** Department of Plant Biology, Cheikh Anta DIOP University of Dakar, BP 5005, Senegal.

Introduction:-

Peanut is grown by more than 100 countries around the world. The 2 main producers providing more than 60% of world production are China and India (FAO, 2019). Africa accounts for 25% of production, with mainly Nigeria, Senegal and Sudan as top 3 contributors (Noba et al., 2014). In Senegal, peanut playsan important rolein most diets, particularly in areas where growthfor conditions the crop is favorable. Peanut is known to contain proteins, vitamins, minerals, carbohydrates, as well as flavonoids such as resveratrol and phytosterols etc. (Awad et al., 2000, Sanders et al., 2000). The work from Griel et al. (2004) demonstrated that through peanut ingestion, consumers benefit froma higher intake of micronutrients. In developing countries, an average daily consumption of around 30gof peanutper personis recommended by the FAO (FAO, 1990) for the treatment of malnutrition.

In Senegal, although production is quite important, average daily consumption would be lower than this value and real data is almost non-existent. Moreover, given the importance of peanut in Senegalese diet, it is important that consumption data iscollected. According to Freud et al. (1996), the average consumption of peanut oil and seeds per capita per year is estimated at 11.7 kg in Casamance, 16.8 kg in the Diourbel, 10.9 kg in Tambacounda, 17.5 kg in the Senegal River Valley and 15.3kg in Kaolack. Preferences and dominant motivations for food choice vary according to nationality, culture and socio-demographic profiles (Prescot et al.,2002; Fotopoulos et al.,2009; Januszewskaet al.,2011; Anderson, 2014; James, 2004).

The aim of the present study is thereforeto assess peanut consumptionin Senegal by measuring intake of foodstuffs made from this crop. This study takes also into scrutiny different parameters related to the socio-economic and cultural status of target groups, the influence of the agro-ecological zone, among others.

Material andMethods:-

Presentation of study areas

Consumption surveys were carried out in four agro-ecological zonesin Senegal: the Peanut Basin (BA), the Eastern Senegal and Upper Casamance (SOHC), the Lower and Middle Casamance (BMC) and the Senegal River Valley (VFS) (Fig1). These areas were selected based on the quantityof production of the targeted foodstuffs, the ranking of peanut at local economy level, the agricultural and demographic status.
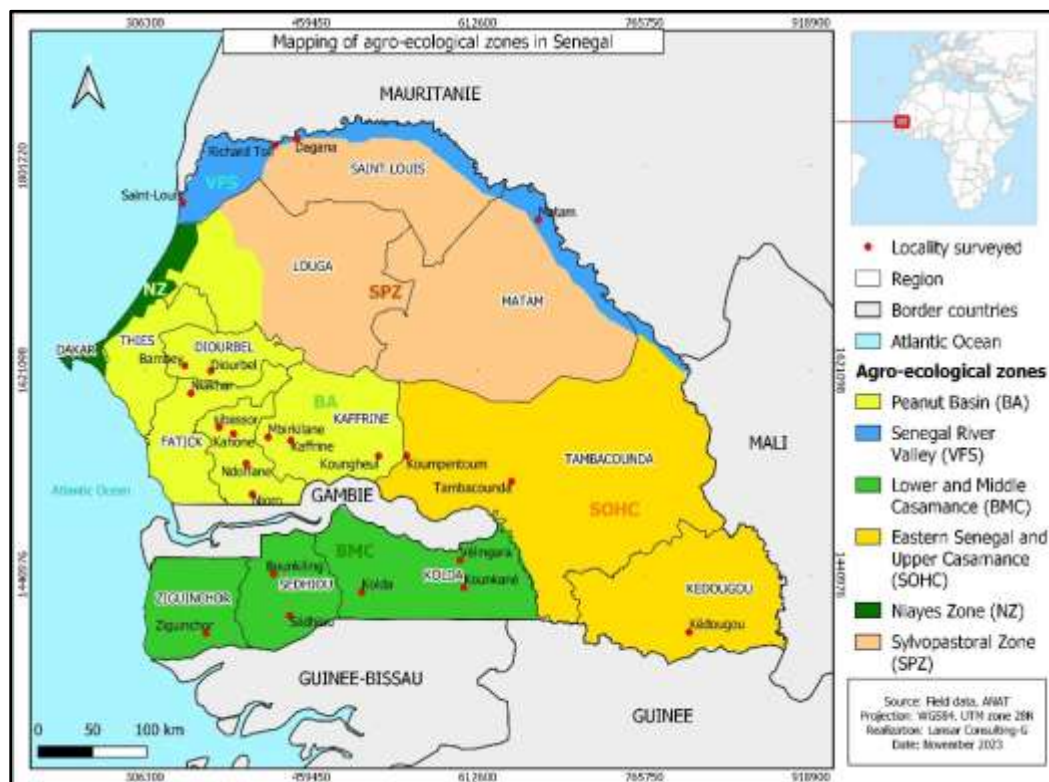

Figure 1:- Location of sample sites.

Data collection
Sampling unit
The sampling unit is made of a householdin the different agroecological zones.

Sample distribution
The consumption survey was conducted at the level of ordinary household. Samplingwas designed according to the principles of simple random sampling (SAS) combined with prior stratification. The total sample size was computed in a way to guarantee representativeness at the level of the administrative region, with respect to the key parameters. The minimum number of households (n) to be drawn was calculated according to the following formulaproposed byANSD (2014):

$$n = \frac{(1 - p) * p * (1.96)^2}{(0.05)^2}$$

Where: n= minimum number of households;
p= 0.5.

An initial sample size of 384 households was obtained for a pvalue of 0.5. The p value of 0.5 is justified by the fact that peanut isconsumed by the majority of households. In order to obtain representative results and to take non-responses and refusals into account, the sample was multiplied by 3, resulting in a total of 1,202 households corresponding to a workforce of 9,616 people out of a total population of 7,373,141 individuals from the agro-ecological zones (AEZ) (ANSD, 2014). The sample was distributed according to the agricultural weights of peanut in the different localities of the targeted agro-ecological zones. The distribution of householdnumberby region and by locality is mentioned Table 1.

Table 1:- Distribution of households in the different agro-ecological zones.

Agroecological zone	Administrative region	Locality	Number of households
Peanut Basin (BA)	Diourbel	Bambey	38
		Diourbel	38
	Fatick	Keur Samba Guéye	44
		Keur Saloum Diané	46
		Niakhar	80
	Kaolack	Kahone	40
		Dya/ Sibassor	52
		Ndoffane	50
		Nioro	60
	Kaffrine	Koungheul	60
		Kaffrine	112
		Mbirkilane	60
Lower and Middle Casamance (BMC)	Kolda	Vélingara	40
		Kounkané	28
		Kolda	60
	Sédhiou	Sédhiou	50
		Bounkiling	20
	Ziguinchor	Ziguinchor	30
Eastern Senegal and Upper Casamance (SOHC)	Tambacounda	Tambacounda	70
		Koumpentoum	30
	Kédougou	Kédougou	40
Senegal River Valley (VFS)	ST Louis	Dagana	32
		Richard Toll	32
		St Louis	60
	Matam	Matam	30

The daily consumption of peanut in a household) (Qα) is obtained by multiplying the average quantity of peanut per dish (Qpx) with the average frequency of consumption of a dish x by a household (FMCpx) per day and by dividing them with the sample size (n). It was determined according to the following formula:

$$Q\alpha = \frac{\sum(Qpx \times FMCpx \propto)}{n\alpha}$$

Where

Qα (g)=Quantity of peanut consumed per day by a household

Qpx (g) = Average quantity per dish

FMCp xα(j) = Average frequency of consumption of a dish xconsumed by the household

nα= Sample size

The quantity of peanut per dish and per person (Qp) is obtained by dividing the average quantity of peanut per dish and per household (of the sample) (n) by the average number of people per household (n'=10.3). The following formula was used:

$$Qp = (\sum QM \div n)/n'$$

Where

Qp = Average quantity of peanut per person per dish

QM =Average quantity of peanut per dish and per household

n = Sample size

n'= Number of people per dish (corresponding to the number of people per household in Senegal) (ANSD, 2014).

The consumption surveys were carried out on the basis of questionnaires derived from the method recommended by the College of Nutrition Teachers (2010). The purpose of the questionnaire was to determine the quantity of peanut consumed by the populations of these four agro-ecological zones. This information made it possible to draw the food consumption diagrams of the populations of the targeted agricultural areas. A list of peanut based dishes was compiled for that purpose (Table 2).

Table 2:- List of peanut-based dishes eaten in the four Agroecological zones.

Dish	Definition
Mafé	A stew eaten throughout West Africa (Senegal, Gambia, Mauritania, Mali, etc. originally) composed of rice and a creamy sauce made of peanut butter (dégué) and tomatoes, frequently with meat or fish and vegetables.
Dakhine	A dish originating in Senegal prepared with rice and peanut butter and powder (noflaye) and other ingredients; most often eaten at the evening meal.
Mbaxalu saloum	Mbaxalu saloum is a favorite Senegalese dish originating in the Sine-Saloum region, whence its name. It is prepared with a generous quantity of white peanut powder (noflaye) and other ingredients, steamed on top of the rice cooking pot for 15 to 20 min before the rice is well cooked.
Laaxu neteurie	This is a porridge made from pearl millet or sorghum flour served with a thick sugared juice made of peanut paste and baobab juice. Laaxu neteurie is most often prepared at ceremonies like baptisms. But in certain regions like Sine-Saloum, it is often prepared for dinner.
Thiouraye guerté	Thiouraye guerté is prepared on many occasions as a snack for children. It is a quick made, low-cost meal. Thiouraye guerté is a porridge made of rice and peanut flour. In other parts of Senegal, it is known as Sombi Guerté.
Nieleng	Nieleng is made of millet with a creamy sauce made of peanut butter (dégué) and tomatoes, frequently served with meat or fish and vegetables. It is a typical Senegalese meal.
Thiéré Bassé	Thiéré Bassé is made of millet with a creamy sauce made of peanut butter (dégué), often served with meat. It is a typical Senegalese meal consumed for dinner and breakfast.

On-site data collection

Data collection took place according to a specific schedule, over the period from 04/12/2020 to 29/02/2021 in the targetagro-ecological zones. The fieldwork required using smartphones with incorporated questionnaires. Applications dedicated to collection were organized in different modules developed using KoBocollect. This software madeit possible to capture, transport and process data collected during interviews. The CAPImethod

allowing data to be collected directly from the field using tablets or smartphones and sent to a well-secured server was used.

Data analysis
The data was analyzed in Excel. Before data analysis, an audit of the database was carried out to verify completeness, consistency and plausibility of the answers provided by the target persons at question level. This operation made it possible not only to clean up the database but also to make it convertible and enable output of tables according to the identified plan.

Results:-
Frequency of consumption of peanut-based-dishes
Mafé, Mbaxalu Saloum and Thiéré Bassé are the most consumed dishes with respective mean frequency of 1.5, 1.3 and 1.6 times per week (Table 3). In the BA, Thiéré Bassé was the most consumed dish with a frequency of twice a week while in the BMC, the SOHC and the VFS it was Mafé. Mbaxalu Saloum is the second most consumed dish in BA and SOHC with respective frequencies of 1.5 and 1.9 times per week. In the different agroecological zones, Nieleng constitutes the dish with the lowest consumption frequency variant from 0 in the BA, 0.2 the VFS, and up to 0.5 in the SOHC and BMC. The cumulative frequency of consumption of peanut based dishes is above 8 for BA, BMC and SOHC while in VFS it reaches only 3.

Table 3:- Consumption frequency ofpeanut-based dishes per weekin the different agro-ecological zones.

	Dish								
AEZ	**Mafé**	**Dakhine**	**Mbaxalu Saloum**	**Laaxu Naterie**	**Nieleng**	**Thiouraye Guerté**	**Thiéré Basse**	**Other**	**Total**
BA	1.5	0.5	1.5	0.1	0	0.7	1.9	0.7	8.4
BMC	1.5	0.8	1.3	0.7	0.5	1.4	1.1	0.9	8.2
SOHC	2.1	0.2	1.9	0	0.2	1.5	1.6	0.6	8.1
VFS	1	0.6	0.2	0.2	0	0.3	0.7	0.1	3.1
Mean	1.5	0.5	1.3	0.2	0.1	0.9	1.6	0.6	6.9

BA (Peanut Basin), SOHC (Eastern Senegal and Upper Casamance), BMC (Lower and Middle Casamance), VFS (Senegal River Valley)

Quantity of peanut used per dish type
Table 4 represents the average quantity of peanut used for the preparation of the different dishes. Dakhine and Thiéré Bassé are the dishes that require peanutthe mostwith an average of nearly 500 g per dish. followed by Mafé and Mbaxalu Saloum with respective quantitiesof 421.2 g and 416.8 g. The quantity of peanut used for the preparation also varies according to the agro-ecological zones. In BA. BMC. SOHC and VFS. the quantities of peanut found in the preparation of Mafé are respectively 45.7g, 217.1g, 358.7g and 613.4g. The preparation of Dakhine requires 546.2g of peanut in the BA and 692g in the VFS.Concerning Nieleng. it is noted that a large quantity of peanut (1048g) is used in the BA and 415.6g in the SOHC during its preparation. In the four agroecological zones. a high presence of peanut in the dishes consumed is observed but in variable quantities.

Table 4:- Quantity (g) of peanut used per dishin the different agro-ecological zones.

	Dish								
AEZ	**Mafé**	**Dakhine**	**Mbaxalu Saloum**	**Laaxu Naterie**	**Nieleng**	**Thiouraye Guerté**	**Thiéré Bassé**	**Other**	**Mean**
BA	465.7	546.2	468.9	576.9	1 048.0	474.8	573.6	417.8	571.5
BMC	217.1	222.1	222.8	192.1	197.3	256.3	191.0	194.9	211.7
SOHC	358.7	402.6	415.2	480.4	415.6	301.0	376.9	508.1	407.3
VFS	613.4	692.0	418.8	493.4	275.0	357.8	652.8	443.7	493.4
Mean	421.2	472.7	416.8	343.9	284.6	369.7	490.4	351.4	393.9

BA (Peanut Basin). SOHC (Eastern Senegal and Upper Casamance). BMC (Lower and Middle Casamance). VFS (Senegal River Valley)

Individual consumptionof peanut through dish type according to AEZ
The quantity of peanut consumed individually varies depending on agro-ecological zones and types of dishes. An individual consumes 9.69g of peanut per Mafé dish in the BA and 10.45g in the SOHC. Consumption of Mbaxalu Saloum allows an individual peanut intake of 9.76g ¨°in the BA. 4.02g in the BMC and 10.94g in the SOHC. A significant quantity of peanut is consumed individually with Thiéré Bassé in BA with an average of 15.12g. The consumption of dishes such as Mafé. Mbaxalu Saloum and Thiéré Bassé gives a daily individual peanut intake of 8.76g. 7.52g and 10.88g respectively (Table 5).

Table 5: - Quantity (g) of individual consumption of peanut per dishin the AEZ.

EZ	Mafé	Dakhine	Mbaxalu Saloum	Laaxu Naterie	Nieleng	Thiouraye Guerté	Thiéré Bassé	Other
BA	9.69	3.79	9.76	0.80	0.00	4.61	15.12	6.82
BMC	4.52	2.46	4.02	1.87	1.37	4.98	2.91	2.61
SOHC	10.45	1.12	10.94	0.00	1.15	6.26	8.36	3.09
VFS	8.51	5.76	1.16	1.37	0.00	1.49	6.34	0.56
Mean	8.76	3.28	7.52	0.95	0.39	4.61	10.88	3.17

BA (Peanut Basin). SOHC (Eastern Senegal and Upper Casamance). BMC (Lower and Middle Casamance) VFS (Senegal River Valley)

Influence of the agroecological zone on daily intake of peanut per individual
Individual daily peanut consumption varies according tothe diet in the agroecological zones. The highest daily intake of peanut is noted in the BA with 50.57g. It is followed by SOHC, VFS and BMC with respective quantitiesof 41.38g. 25.18g and 24.73g(Fig 2).
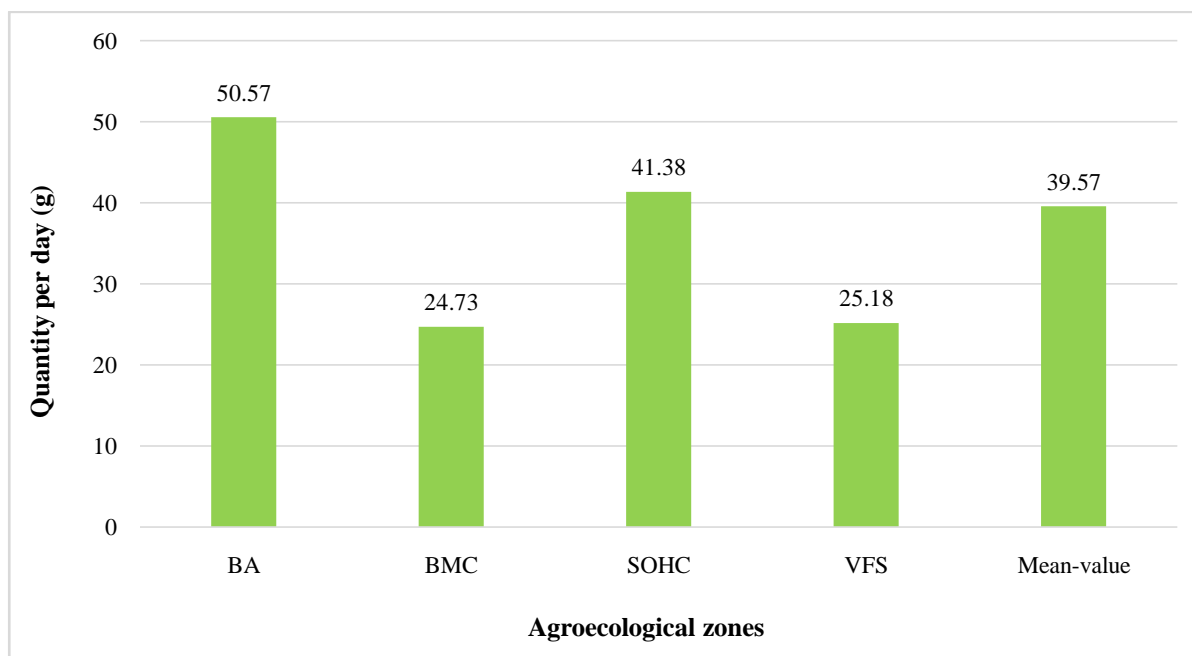
Figure 2:- Average daily peanut consumption per person according to the AEZ.

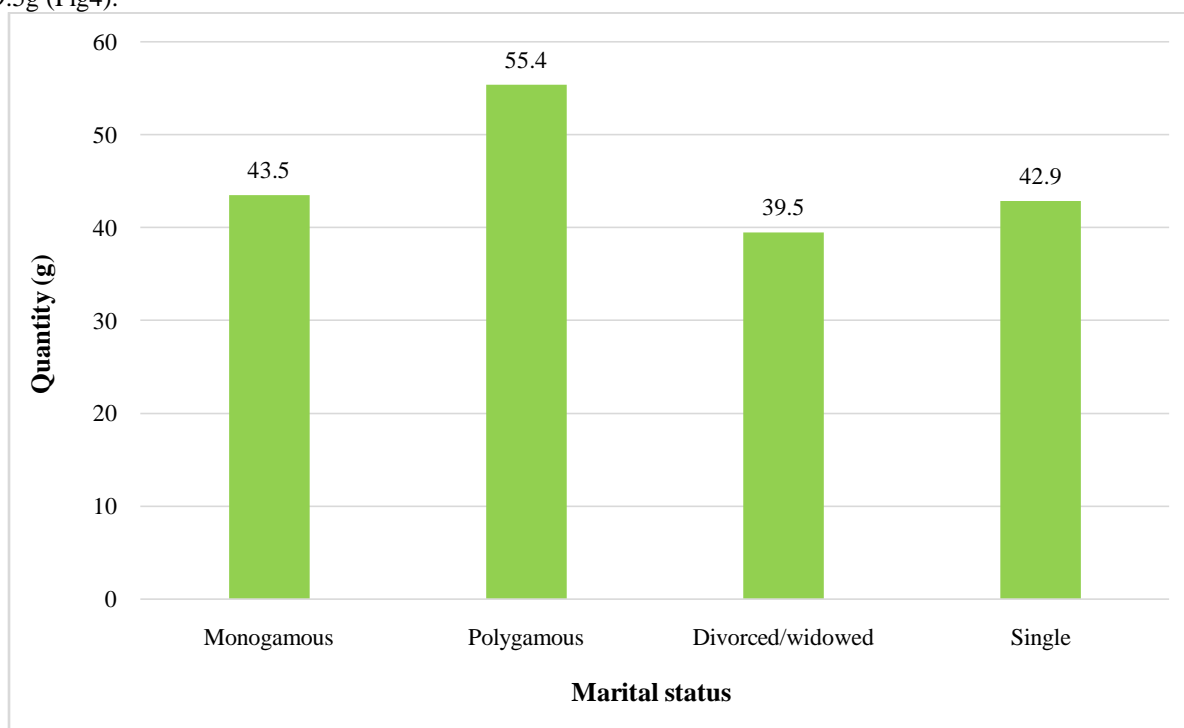**Influence of the gender of head of household on daily consumption of peanut**
The overall data showed that in household headed by men, daily consumption per capita consumption of peanutis higher. Individuals from households headed by a man consume on average 50g of peanut whileinfemale-headed householdsconsumption level is about 40g per person (Fig 3).
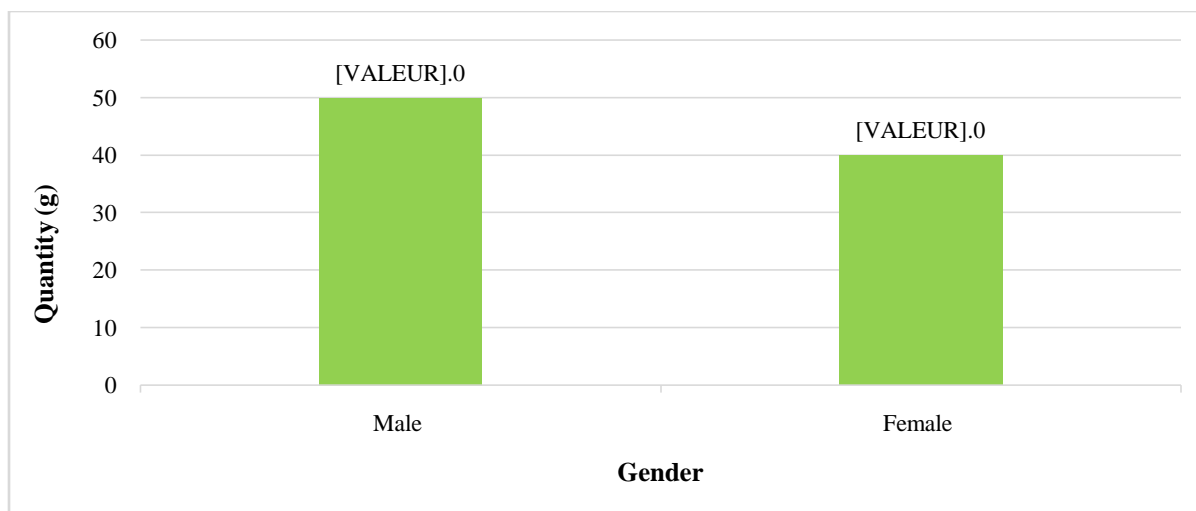
Figure 3:- Average daily peanut consumption per person according to gender of head of household.

Influence of marital status and/or number of wives of the head of household on daily intake of peanut

Peanutisconsumed in higher quantityin polygamous households where top quantities of 55.4 g are ingested daily by an individual. The peanut quantity per person is lower in households led by people with other marital status like monogamous households. single adult people and divorced/widowers with respective averages of 43.5; 42.9 and 39.5g (Fig4).
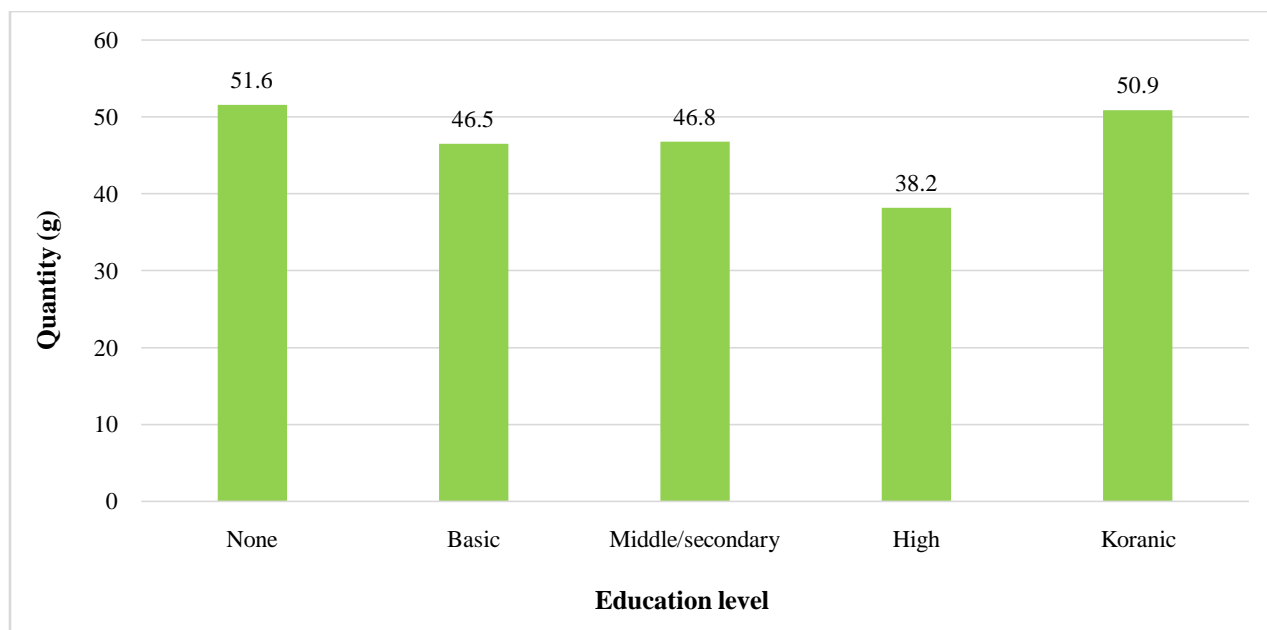

Figure 4:- Average daily peanut consumption per person according to the marital status of the household head

Influence of education level of head of household on consumption of peanut

Peanut consumption varies significantly depending on the level of education of the head of household. The highest consumption level is noted in households where the heads have not gone to school with an average of 51.6g(Fig5). This is followed by households where the head attended Koranic School where consumption reached 50.9g of peanut per person per day. Individuals in householdsheaded by people with higher education have the lowest peanut consumption with a daily intake of 38.5g per person.
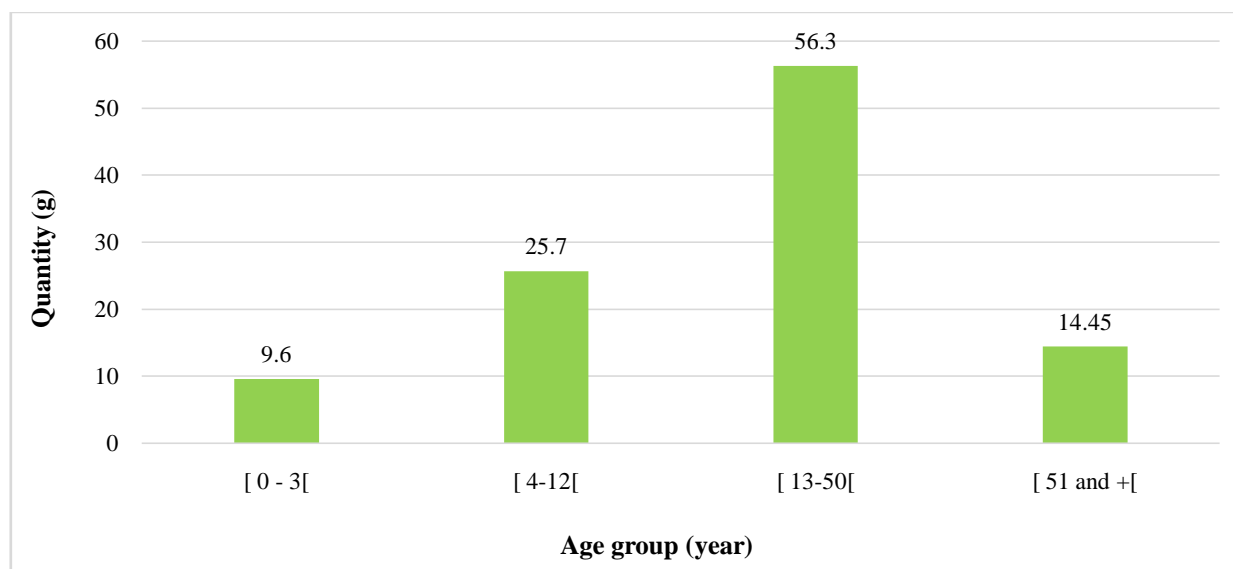
Figure 5:- Average daily peanut consumption per person according to the level of education of the household head.

Level of individual consumption of peanut according to the age group
Peanut consumption is at highest in the 13-50 age group with a daily intake of 56.3g (Fig 6). This is followed by the age groups 4 - 12 years. 51 and + and 0 - 3 years with respectiveaverages of 25.7g. 14.4g and 9.6g.

Figure 6:- Average daily consumption of peanut per person according to age group.

Discussion:-
Peanutis an important food and oilseed crop in Senegal.It is used in daily basis to make various dishes that are very popular in Senegal. People in the Peanut Basin (BA). Eastern Senegal and Upper Casamance (SOHC). Lower and Middle Casamance (BMC) and the Senegal River Valley (VF)commonly consume this foodstuff with variablefrequency.

The data collected across these 4 agroecological zones showed consumption frequencies of peanut-based-dishes above once a week through the 4 main dishes. Infact, Mafé, Mbaxalu Saloum and Thieré Bassé are frequently consumed with respective average of 1.5, 1.3 and 1.6 times per week in the four agro-ecological zones. In the Peanut

Basin, Mafé using approximately 465.7g per dish is consumed once to twice a week. The same trend is observed for Mbaxalu Saloum in the BMC where 222.8g of peanut is used to prepare the dish. Theseresults are similar to those of Adhikari et al. (2018) who showed that the frequency of peanut consumption in Malawi was about1.01 to 2.35 per week. The preparation of Niéleng and Laaxu Neteurie required an average of 1048 and 480.4 g of peanut in BA and SOHC respectively. In the VFS, nearly 692 g of peanutisused in the Dakhine dish while 256.3 g isused to cook the Thiouraye Guerté dish in the BMC.This shows that the agroecological zone plays an important role in the diversity of peanut based dishes that are consumed as well as in the quantity of peanutused to make the same dish. As a matter of facts, the higher peanut content per dish is noted in the BA and SOHC. This could be linked to the easy access to the crop, the uses and customs, the cheap price of peanut and cultural factors in those 2 zones known as the peanut basin of Senegal.The high frequency of consumption of peanut-based dishes in BA, BMC and SOHC (more than 7 times a week in total) could be attributed to households having at least twice a week a peanut based dish. This is very likely since among the setup of dishes, some like Laaxu Neteurie and Thiouraye Guertéare often consumed for breakfast, others like Mafé, Mbaxalu Saloum, Nieleng, Dakhine are eaten at lunch and Laaxu Neteurie, Thiéré Bassé, Thiouraye Guertéused for dinner (Diène, 2015). This high consumption of peanut could be brought in relation withan availability of the resource in large quantity in these areas. These 3 AEZ are known to be the main peanut providers of the country (ANSD, 2015). Infact, the climaticconditions, with a rainfall of more than 400mm per year and the sandy-clayey soils with pH values of 6.5 to7.5 that offer ideal conditions for the production of peanut.The low consumption level of peanut in the VFS could be linked with the low production level in one hand and in the other hand, culinary customs with less space for peanut. As an example, the almost zero frequency of consumption of Nieleng, a dish made of millet with a creamy sauce made of peanut butter (degué) and tomatoes in the VFS is linked to absence of pearl millet in this area where rice is the staple food and the most cultivated crop and therefore the most available for the population. Another contributing factor may be the fact that the most populated cities attracting trade, in particular that of peanut, are located outside this area.

The daily consumption of peanut per person is the highest in BA with 50.57gand SOHC with 41.38g. This is equivalent to a yearly quantity of 18.45kg and 15.11 kg of peanut respectively. These 2 AEZ represents the high production areas with peanut playing a huge role in culinary habits.These results are similar to those of Freud et al. (1996) who reported highest consumption of peanut in BA, VFS and SOHC with an average of over 15kg per year.In Senegal, the regions of Kaffrine, Kaolack and Fatick situated in the BA represent 47% of the national peanut acreage and account for more than 52% of country production. From 2006 to 2014, the region of Kolda (SOHC) was the better performer with an average yield of 1335kg/ha followed by Kedougou (SOHC) with 1112kg/ha (ANSD, 2015). The BMC plays also an important role in peanut production. However, the consumption level is the lowest with 24,73g per person daily leading to a yearly total of 9 kg per person. The culinary customs, in relation with the population setup in terms of ethnic groups in this area and also the most recent integration of peanut in the production landscape could be part of the explanation.In the VFS the average daily ingestion of 25.18g/per person brings the total quantity to 9.19kg/year.

In man-led householdsan average of 50g of peanut is consumed per person at a daily basis. This quantity drops down to 40g in woman-led households. The high consumption of peanut in households headed by a man could be linkedto the economic capacity and the size of the household. In fact, households headed by a man are often made ofmore people, meaning more workforce, with as a consequence, more peanut isavailable. This makes it easier to achieve food security. The woman-led-households are often of smallersize and have a tendency to vary their diet. This could be seen as a strategy to achieve food security that brings alongside nutritional benefits. It has also been reported in Senegal that 57% of households headed by a womanare in a better food security situation. This rate goes down to 53.2% for households headed by men(SECNSA, 2016). In polygamous families, the daily peanut consumption per person is estimated at 55.4g. Household heads take advantage of the availabilityof peanut, inrelation of the larger family size that increases the workforce, to feed the entire family. This may explain the high consumption of peanut-based dishes.

Divorced or widowed people often have a lower number of dependents, which can help diversify the diet. This may explain the decrease in the quantity of peanut consumed per day per person (39.5 g) compared to polygamous families (55.4 g). People in households where the head has not attended school consume 51.6g of peanut followed by those who have attended Koranic school with 50.9g of peanut per day. Individuals in households headed by people with higher education have the lowest peanut consumption with a daily intake of 38.5g per person, followed by those with Basic level (46,5g) and middle/secondary (46,8g). This points out differences in consumption in relation with the education level. The socio-economic aspects of population studies tend to link people with higher

education with higher income that allow the household to access food diversity and quality. In these rural areas, low-income households are often led by small and casual traders, farmers or cattle holders. These households tend often to focus on quantity to sustain their livelihood and reach food security. In this context, the nutritional aspectsof food sources are often not viewed as primary objectives, but can be combined when the crop with the higher yields brings alongside also nutritional assets.The age group 13-50, with a daily peanut consumption of 56.3g per person represents the biggest consumers.This could be explained by this range considered to be the working age where naturally food intake is higher compared to the age groups 0 – 3 years and over 51 where the daily peanut consumptions are respectively 9.6g and 14.4g.

Bioscope et al. (2015) has reported the high consumption of peanut-based-dishes in BA and SOHC which represent main peanut production areas. In the BMC a large part of peanuts is intended for sale which can explain the low quantity used in frequently consumed dishes compared to other agroecological zones. People living in households headed by a man, made by many people, more workforce and more availability of peanuts, consume more than 20% peanuts than those living in households headed by a woman. The peanut consumption in polygamous familiesis 28% higher than among divorced people. This can be explained by the fact that divorced peoplehave a reduction in the number of dependents. The high consumption of peanuts noted in the 13-50 age group (56.3g per person) is due to that it is the working age and where the body's nutritional needs are much greater.

Conclusion:-
This study was conducted in four agro-ecological zones in Senegal; the Peanut Basin (BA), the Lower and Middle Casamance (BMC), the Eastern Senegal and Upper Casamance (SOHC) and the Senegal River Valley (VFS) to generate data about the consumption of peanut in Senegal.The results showed that the consumption of peanut is more important in the BA and the SOHC with a larger diversity of peanut based dishes and a daily ingestion reaching 1048g per person through the diets.In a man-led household, the consumption of peanut per person at a daily basis is higher than in woman-led-household. The same mean is observed to polygamous families compared to divorced or widowed people. Peanut consumption is much higher in the age group 13-50. These results provide crucial information on the consumption of a basic foodstuff in four agro-ecological zones of Senegal and the importance of peanut in Senegalese diet.

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