

Assessment of Presence of Edible Oil Brands in Bangladesh and their vitamin A content



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Acronyms

BCSIR	Bangladesh Council of Scientific and Industrial Research
BBS	Bangladesh Bureau of Standards Statistics
BSTI	Bangladesh Standards and Testing Institution
CC	City Corporation
CV	Coefficient of variation
ERC	Ethical Review Committee
FAO	United Nations Food and Agricultural Organization
FFA	Free fatty acids
GAIN	Global Alliance for Improved Nutrition
GMP	Good manufacturing practice
HIES	Household Income and Expenditure Survey
HPLC	High-Performance Liquid Chromatography
ICDDR,B	International Centre for Diarrheal Diseases and Research, Bangladesh
IFST	Institute of Food Science and Technology
MC	Municipal Corporations
Mol	Ministry of Industry
MU	Measurement uncertainty
NBL	Nutrition Biochemistry Lab
NCSD	Nutrition and Clinical Services Division
NMS	National Micronutrient Survey
POV	Peroxide value
PPM	Parts per million
QA	Quality assurance
QC	Quality control
RE	Retinol Equivalents
UC	Union Council
UNICEF	United Nations Children's Fund
WFP	World Food Program
WHO	World Health Organization

1 Executive summary

Micronutrient deficiencies, and particularly Vitamin A deficiency is widespread in Bangladesh. Large-scale food fortification of vegetable oil (mean consumption of edible oils is 24.4 g/day/consumer (National Micronutrient Survey in Bangladesh in 2011-12, 2011)) is one of the most sustainable and cost-effective solution to improve the nutrition status of populations at risk. In Bangladesh, the legislation mandating the fortification of edible oil with Vitamin A was passed in 2013. A cross-sectional market survey was conducted by the Global Alliance for Improved Nutrition (GAIN) with support from the International Centre for Diarrhoeal Disease Research, Bangladesh (icddr,b) and in collaboration with the Ministry of Industry (Mol) in Bangladesh (1) to assess the presence¹ of edible oil brands, including imported and locally produced brands and unbranded oils in selected markets across the eight divisions of the country, and (2) to compare the vitamin A content of the edible oil brands with the national edible oil fortification standards². The results of this survey inform programmatic decisions and support effective implementation of the edible oil food fortification program in Bangladesh.

In total 553 retail outlets: retail shop, supermarket and wholesaler were visited in the eight divisions of Bangladesh to record the available oil brands using standard questionnaires.

There were 97 packaged oil brands identified in the country and three types of oil were sold as bulk: palm oil, soybean oil and super palm oil. From the total number of packaged oil brands found, 39% are soybean oil, 20% rice bran oil, 19% sunflower oil, 18% are palm oil, 3% are vegetable oil, 1% is canola oil and 1% is super palm oil brands. Seventy-seven locally produced (79%) and 21 imported brands (21%) were found³. Soybean oil, rice bran oil, palm oil, vegetable oil blends and super palm oil brands are mainly produced locally while sunflower oil and canola oil are mostly imported. Of these, eight main brands are found in seven or even all 8 divisions of Bangladesh, while the other 64 brands are found in only 2 divisions or less.

In addition, three types of oil were sold as bulk; palm oil, soybean oil and super palm oil. Bulk palm and soybean oil are sold in all divisions visited, while super palm oil was found in 7 of 8 divisions.

The highest variety of packaged oil brands were available in Dhaka and Chittagong division, while the lowest variety were available in Khulna and Rangpur.

For the main packaged oil brands (66 packaged brands), oil samples from different batches or retail outlets were taken and analyzed for nutrient content of vitamin A and compared to the national

¹ The term presence is used in this report interchangeably with availability to designate the brands that were found in the market.

² Conformity of the samples with national standards was identified, but it does not imply legal compliance.

³ One of the brands identified under the same label name is produced both locally and imported so it is counted under both categories.

fortification standards. Based on the average fortification status of brands, 26 brands were found not to be fortified (39%), 40 oil brands were fortified (61%) and 28 of them above the standard minimum (70% of the fortified brands). More than a third of the local brands were not fortified (40%) while all imported brands analyzed were fortified above the standard minimum.

The market volume for packaged oil brands (estimated at 900,000 MT) found during the assessment represents about 35% of the total oil market volume estimated at 2,600,000 MT and the brands analyzed (about 890,000 MT) represent about 34% of the total market volume. Of the assessed packaged oil market volume, about 95% is fortified (corresponding to the market volume of 40 brands) and more than two thirds (69%) is fortified above the minimum of the fortification standard (corresponding to the market volume of 28 brands), and only about 5% is not fortified (corresponding to market volume of 26 brands). The brands that make up a large proportion of the packaged oil are fortified above the minimum of the standard. However, smaller refineries do not seem to fortify their brands.

In total, 41 composite samples of bulk oil were collected and analyzed across three types of oil (palm, soybean, and super palm oil). Over two-thirds of the bulk palm oil samples (69%), half of soybean samples (50%) and nearly two-thirds of super palm oil samples (63%) were not fortified. Only 1 composite sample of soybean oil (5%) and 2 composites of bulk super palm oil (25%) were fortified above the standard minimum.

The fortification status of the assessed market volumes (99% of 2,600,000 MT) for both packaged and bulk oil shows that over half of oil volume (59%) available in Bangladesh is fortified and about a third (27%) is fortified above the standard minimum. This is higher for packaged oil (which has a lower market share) of which 95% was fortified (69% above minimum standard), compared with bulk oil 41% of which was fortified (7% above minimum standard).

This assessment shows that market assessments can identify fortification status of oils available in the market. The main locally produced and imported packaged brands are fortified above the minimum of the fortification standard, but fortification of smaller locally produced as well as oil sold as bulk need to be improved. BSTI should prioritize inspections of producers and support them to only supply traceable and fortified oil, particularly of oil currently sold as bulk. With further research on the consumption and coverage of different oil brands and bulk oil types in different population groups potential additional micronutrient intake and reduction of their micronutrient gaps can be assessed.

2 Background

Micronutrient deficiencies are one of the most serious health problems in the developing world; they have severe negative impact on children's ability to grow and to fight diseases and on families and societies as a whole. According to World Health Organization report (World Health Organization, Food and Agricultural Organization of the United Nations, 2006) Micronutrient deficiencies are often referred to as 'hidden hunger' because they develop gradually over time and their devastating impact is not seen until irreversible damage has been done. Micronutrient malnutrition is a major concern not only because large numbers of people are affected but also because macronutrient malnutrition being a risk factor for many diseases, it can contribute to high rates of morbidity and mortality. Millions of children suffer from stunted growth, cognitive delays, weakened immunity and other diseases as a direct result of micronutrient deficiencies. For pregnant women, the lack of essential vitamins and minerals can increase the risk of low birth weight, birth defects, stillbirth, and even lead to death. It has been estimated that micronutrient deficiencies account for about 7.3% of the global burden of disease with iron and vitamin-A deficiency being in the top of the list (Allen, Benoist, Dary, & Hurrell, 2006). Micronutrient deficiencies are caused by immediate factors such as inadequate intake of nutritious foods and infectious disease and other underlying factors like poverty and unhealthy environments.

In Bangladesh, micronutrient deficiencies are endemic and affect all age groups. As an indicator for iron and other micronutrient deficiencies, anemia prevalence is high: two in three children aged 6-23 months, almost one in two pregnant women and one in three adolescent girls suffer from anemia. Other common deficiencies include iodine, vitamin A, calcium and zinc. Deficiency of vitamin-A is a major cause of serious immunodeficiency, thus increasing the risk of death by infectious diseases and preventable night-blindness in children in Bangladesh (United Nations Children's Fund). The Bangladesh Micronutrient Survey of 2011-2012 reports that 36% of children of pre-school age are vitamin-A deficient. In pregnant and postpartum women, vitamin-A deficiency has an even higher potential negative impact for their own health and survival and their child's (National Micronutrient Survey in Bangladesh in 2011-12, 2011).

A large segment of the population of Bangladesh survives on a diet that lacks diversity (Food and Agriculture Organization of the United Nations, 2007). Rice and cereals are the most consumed dietary staples. The main driver behind the lack of diversity in the diet is the high prices and in some cases wrong beliefs and lack of nutritional knowledge. The Bangladesh Demographic and Health Survey (Bangladesh Demographic and Health Survey, 2011) and the National Micronutrient Status Survey (National Micronutrient Survey in Bangladesh in 2011-12, 2011) show that vitamin-A supplementation programs are inadequate as they only address the needs of some sub-groups and not the whole population.

Fortification of food with micronutrients is a cost-effective technology for reducing micronutrient malnutrition as part of a food-based approach when and where existing food supplies and limited

access fail to provide adequate levels of the respective nutrients in the diet. Food fortification refers to the addition of micronutrients to processed foods. In many situations, this strategy can lead to relatively rapid improvements in the micronutrient status of a population, and at a very reasonable cost, especially if advantage can be taken of existing technology and local distribution networks. Since the benefits are potentially large, food fortification can be a very cost-effective public health intervention. However, an obvious requirement is that the fortified food(s) needs to be consumed in adequate amounts by a large proportion of the target individuals in a population. It is also necessary to have access to, and to use, fortificants that are well absorbed yet do not affect the sensory properties of foods. In most cases, it is preferable to use food vehicles that are centrally processed, and to have the support of the food industry. GAIN's food fortification model works with governments, businesses, international organizations and civil society partners to fortify staple foods and condiments.

GAIN partnered with UNICEF Bangladesh to implement the first phase of the program (2010-2013) to fortify with Vitamin A all refined edible palm and soybean oil in Bangladesh. The aim was to contribute to the reduction in prevalence of vitamin A deficiency in the population of Bangladesh through consumption of vitamin A fortified edible oil. In Bangladesh, ninety-nine percent of the population consumes vegetable oil (Fiedler, et al., 2015). Two extensive recent national surveys reported similar results: The National Micronutrient Survey (NMS) revealed that the mean consumption of edible oils is 24.4 g/day (rural: 22.9 g/day and urban 29.7 g/day) and the Household Income and Expenditure Survey (Household Income and Expenditure Survey (HIES), 2010) reports 20.4 g/day. Phase II (2013-2015) extends cooperation with the Ministry of Industry (Mol) and refineries to reach full-scale sustainable production of quality-assured fortified edible oil. GAIN provides financial and technical support to the Bangladesh government, vegetable oil refineries, national nutrition committees and development partners, to create an enabling environment, raise awareness of the benefits of oil fortification with vitamin A, improve the quality of fortified oil and scale up fortified oil production to reach the majority of the Bangladeshi population. The objective of this second phase was in turn to contribute to the progress toward achieving the Millennium Development Goals and the Sixth Five Year Plan (2011-2015) through the contribution to the reduction of the under-five mortality rate and maternal mortality ratio.

There is limited data availability regarding the fortification content of edible oil with vitamin A in Bangladesh. According to data from the Mol, most of the large and small refineries have started fortifying edible oil with vitamin A. However, no study was conducted to assess the availability of oil brands and their fortification content with vitamin A in Bangladesh. The aim of this market assessment is to contribute to filling this gap by assessing the availability of oil supplied by refineries and re-packers to markets and analyzing their compliance with edible oil fortification standards.

3 Objective of the Project

The objective of the study is to determine the presence of oil brands in major urban and rural markets in all 8 division of Bangladesh and collect samples of oil brands to assess their fortification content and compare them with fortification standards in Bangladesh.

The specific objectives are twofold:

1. to determine the type of oils sold as bulk or packaged brands and their respective producers or suppliers, their origin, price, packaging and labeling that are present in:
 - a. the country
 - b. different divisions
 - c. urban and rural markets
 - d. different retail outlet types;

2. to assess the average vitamin A content of available packaged oil brands and oil sold in bulk (or defined oil sampling units) and their fortification content compared to national standards (compliance):
 - by oil type
 - by brand
 - by origin
 - by price
 - by division
 - by fortification label
 - by rural and urban areas
 - by market volume

The market assessment results can inform technical and programmatic decisions to implement an effective fortification program of all major edible oil brands available in Bangladesh.

4 Methodology

4.1 Survey teams and implementation plan

4.1.1 Survey teams

Icddr,b team consisted of a Principal Investigator (PI) to lead the implementation of the survey, a Senior Research Officer (SRO) responsible for the overall coordination and two teams that travelled across the country to collect data and oil samples for analysis. Each team comprised a Research Officer (RO), a Field Research Supervisor (FRS), a Field Attendant (FA) and two Field Research Assistants (FRAs) (Table 1). The PI is responsible for the data analysis, the reliability of results and the report writing. The SRO is responsible for the overall coordination, the quality control and monitoring of the assessment.

Table 1: Team composition

Team	Designation	Areas visited
Gulshan Ara (PI)	Lead	Dhaka, Tangail, Comilla,
Dr. Tahmeed Ahmed (Co-PI)	Co-lead	Dhaka
Dr. Baitunnahar (Co-I)	Technical Support	Dhaka
Mansura Khanam (SRO)	Co-ordination	Dhaka, Tangail, Comilla
Anjon Kumar Roy and Sadia Sharmin	Lab personnel	
Ahsanul Haque and Debi Rani Chakrovarty	Data management team	
Abir Hossain (FRO), Trisheeta (RO), Md. Neaj Morshed (FRA), Md. Masum Billah (FRA), Jahid Hasan (FA), Imran Hossen (FA), Najia Hasan (FRS)	Team A	Dhaka, Mymensingh, Rangpur, Rajshahi, Khulna
Olam MD Shohan (FRO), Md. Tanvir Hasan Jami (FRS), Mamunur Rashid (FRA), Kamal Mia (FRA), Khadiza Khanam (FRA), Rakib Khan (FA)	Team B	Dhaka, Chittagong, Sylhet, Barisal, Khulna,

4.1.2 Implementation plan

The market assessment was conducted in each division of Bangladesh from March to June 2017. The data collection dates and divisions visited by each team are presented in Table 2.

Table 2: Data collection schedule

Team A	Date	Division	Team B	Date	Division
Abir Hossain (FRO)	12-14 Mar	Dhaka	Golam MD Shohan (FRO)	12-14 Mar	Dhaka
Trisheeta (RO)	15-17 Mar	Mymensingh	Md. Tanvir Hasan Jami (FRS)	15-17 Mar	Chittagong
Md. Neaj Morshed (FRA)	18-20 Mar	Rangpur	Mamunur Rashid (FRA)	18-22 Mar	Sylhet
Md. Masum Billah (FRA)	21-24 Mar	Rajshahi	Kamal Mia (FRA)	22-27 Mar	Barisal
Jahid Hasan (FA)	28-30 Mar	Khulna	Khadiza Khanam (FRA)	28-30 Mar	Khulna
Imran Hossen (FA)	7-10 April	Dhaka*	Rakib Khan (FA)	7-10 April	Dhaka*
Najia Hasan (FRS)			Najia Hasan (FRS)		
*Additional sample collection					

4.2 Study design and data collection

Data collection took place in different retail outlet types in purposefully selected urban and rural market hubs of major cities, towns and villages across the 8 divisions of Bangladesh. Data collection included: brand names, production sites, packaging types and sizes as well as the existence of a fortification label/ statement.

Bangladesh is divided into eight administrative divisions: Barisal, Chittagong, Dhaka, Khulna, Mymensingh, Rajshahi, Rangpur and Sylhet (Figure 1). Each division is divided into districts (*zilas*) that are sub-divided into City Corporations (CC) that are the biggest cities and sub-districts (*upazilas*) (Figure 2). In the *upazilas*, the metropolitan areas or towns are called *Paurasabhas* or Municipal corporations (MC) and Union councils (UC) define the rural areas. They are all further divided into *wards*. In rural areas, *wards* are also designated as *villages*.

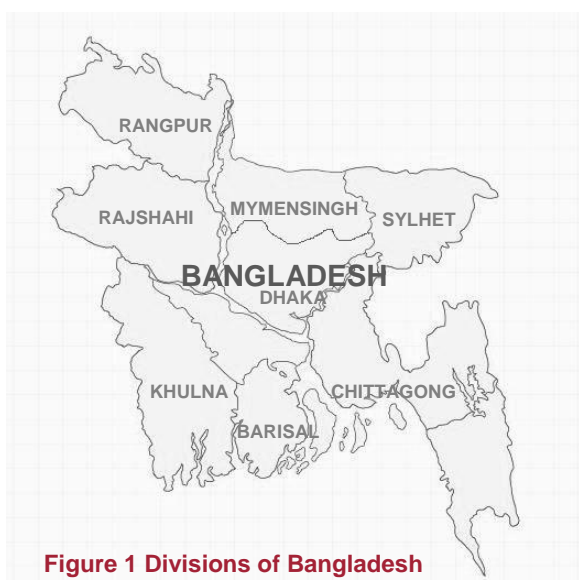


Figure 1 Divisions of Bangladesh

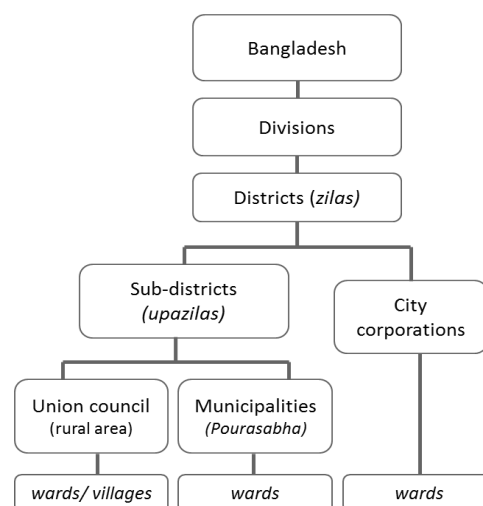


Figure 2 Administrative divisions of Bangladesh

4.2.1 Market hubs selection

Market hubs are agglomerations with high population density and where larger volumes of food products are sold or passed through and dispatched to other places. Selected market hubs are located on the nodes of the main supply routes of oil. Market hubs are delineated through administrative units of the country which a map of the main infrastructure network of a country can help outline. Places supplied from these hubs are expected to have the same or a selection of the variety of brands available in the market hub they are supplied from. Oil availability in these market hubs is expected to be representative of the oil that can be accessed by the population using the markets.

In Bangladesh, there is a tremendous disparity between standards of living in urban and rural areas according to the Bangladesh Bureau of Statistics (BBS, 2010). Both urban and rural market hubs

were visited in each division of the country as the offer of edible oil was expected to be different. CCs and MCs are the market hubs in urban areas. Villages (wards) in a UC are the market hubs in rural areas. In each division, data was collected in urban market hubs (a CC and a MC) and rural market hubs (three villages); except in Mymensingh division where there is no CC and where two MCs in the same district were visited instead as urban market hubs.

Data from the Population Census 2011 of the BBS and from the local government websites was used as a reference to estimate the population in the administrative areas (district, CC, MC and UC) of the country. In each division, the district that included the CC with the largest population was selected (Table 3). Among the remaining districts, the district with the largest population was selected to determine the sub-district (*upazila*) with the largest population. Then, in the selected *upazila*, the municipality with the largest population (Table 4) and the three largest villages (*wards*) in the UC with the largest population were purposively selected (Table 5). For more details refer to Annex 1 - Market hubs selection in each division.

Table 3: Selected divisions and City Corporations with largest population

Abbr.	Division	Division Population	District	District Population	City Corporation	City Corporat. Population
BAD	Barisal	8,325,666	Barisal	2,324,310	Barisal	328,278
CHD	Chittagong	28,423,020	Chiattagong	7,616,353	Chittagong	2,581,643
DHD	Dhaka	47,424,418	Dhaka	12,043,977	Dhaka North	3,957,302
MYD	Mymensingh					
KHD	Khulna	15,687,759	Khulna	2,318,527	Khulna	663,342
RJD	Rajshahi	18,484,858	Rajshahi	2,595,197	Rajshahi	448,087
RAD	Rangpur	15,787,758	Rangpur	2,881,086	Rangpur	795,556
SYD	Sylhet	9,910,219	Sylhet	3,434,188	Sylhet	479,837

Table 4: Selected districts, sub-districts and municipalities with largest population

Abbr.	Division	District	District Population	Sub-district <i>upazila</i>	Sub-district Population	Municipality <i>Paurashava</i>	Municipality Population
BAD	Barisal	Bhola	1,776,795	Char Fasson	456,437	Char Fasson	19,595
CHD	Chittagong	Comilla	5,387,288	Comilla Adarsha Sadar	532,419	Comilla	222,676
DHD	Dhaka	Tangail	3,605,083	Tangail Sadar	521,104	Tangail	167,412
MYD	Mymensingh	Mymensingh	5,110,272	Mymensingh Sadar	775,733	Mymensingh	258,040
	Mymensingh	Jamalpur	2,292,674	Jamalpur Sadar	615,072	Jamalpur	142,764
KHD	Khulna	Jessore	2,764,547	Jessore Sadar	742,898	Jessore	201,796
RJD	Rajshahi	Bogra	3,400,874	Bogra Sadar	555,014	Bogra	400,983
RAD	Rangpur	Dinajpur	2,990,128	Dinajpur Sadar	484,597	Dinajpur	186,727
SYD	Sylhet	Sunamganj	2,467,968	Chhatak	397,642	Chhatak	44,364

Table 5: Selected union councils with largest population

Abbr.	Division	District	District Population	Sub-district upazila	Sub-district Population	Union Council	Union Council Population
BAD	Barisal	Bhola	1,776,795	Char Fasson	456,437	Ilisha	46,924
CHD	Chittagong	Comilla	5,387,288	Comilla Adarsha Sadar	532,419	Uttar Durgapur	54,913
DHD	Dhaka	Tangail	3,605,083	Tangail Sadar	521,104	Arankhola	59,895
MYD	Mymensingh	Mymensingh	5,110,272	Jamalpur Sadar	615,072	Pogaldigha	53,002
KHD	Khulna	Jessore	2,764,547	Jessore Sadar	742,898	Noapara	54,878
RJD	Rajshahi	Bogra	3,400,874	Bogra Sadar	555,014	Garidaha	48,511
RAD	Rangpur	Dinajpur	2,990,128	Dinajpur Sadar	484,597	Auliapur	46,925
SYD	Sylhet	Sunamganj	2,467,968	Chhatak	397,642	Jamalganj	51,604

Distribution of the data collection sites in the selected districts across the country are displayed in Figure 3 (CC market hubs in blue and MC and villages in the UC in red).

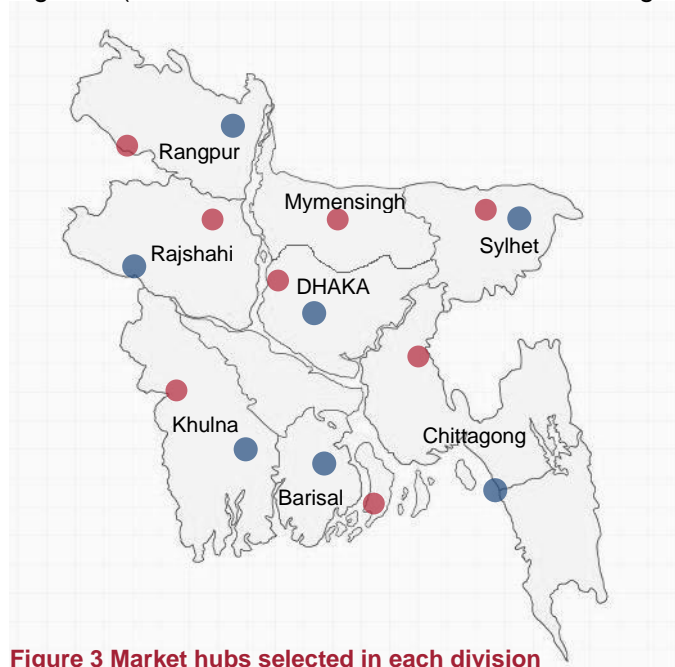


Figure 3 Market hubs selected in each division

4.2.2 Market place selection: defining areas within market hubs

It was expected that urban market hubs would be larger and have a wider socio-economic heterogeneity spread than rural market hubs. There are not as many market places in rural market

hubs (villages) as in urban market hubs. Rural market hubs may only have one market place. A market place is defined as a place where a high number of vendors or retail outlets are concentrated and where buyers and sellers of vegetable oil are able to interact. Therefore, in the selected rural areas (UC), the three biggest villages (*wards*) were selected as a marketplace, meaning 3 market hubs. The required information about the size and population of the villages was obtained from the local government office. In urban settings, market hubs were subdivided into three areas defined through high disparities in the socio-economic status of the majority of the population living in these areas (e.g. a high socio-economic status residential area and an area that was defined as a slum or low socio-economic status area). These differences in the population characteristics in those areas can affect the demand that will influence the range of products proposed/sold by retail outlets.

Identification of the areas was determined by the teams upon their arrival in each market hub. Area selection was determined by the size and importance of the marketplace. An area that could not be defined as neither low nor high socio-economic status was simply defined as other. Information on how to delimitate the market hub into three distinct areas was provided by the local government office (e.g. Mayor/Counselor, Secretary from the Municipalities and Chairman from the *Union Parishad*) to gather information. Local people also provided valuable information on the population density, socio-economic status of local people by area, and popular local marketplaces. The largest and most popular market place in each or in proximity of each of the three defined areas (A1, A2 and A3) was then visited.

The three areas were defined as follow:

A1 = area 1: high socio-economic status residential area

A2 = area 2: other than high or low socio-economic status residential area

A3 = area 3: low socio-economic status area/ slum area

4.2.3 Retail outlet selection

Background research was conducted by GAIN with support from icddr,b to understand the structure of the oil supply chain and identify the main retail outlet types through which oil is sold. Retail outlets are defined here as a general term for vendors or businesses that sell edible oil (e.g. wholesalers, retail shops, super markets and exporters). The range of products in a retail outlet depends on its customer demand and its supply chain access. In different areas of a market hub, retail outlets of the same type may have a different product range due to differences in customers and the product range of their wholesaler/suppliers. To capture this diversity, particularly in large market hubs, different retail outlets types located in different areas in a market hub were visited (Figure 4).

The main retail outlet types that can be differentiated in Bangladesh are defined below:

- a) **Retail shop (R):** a small sale outlet offering variety of goods to a local community of area, like convenience store. Stores can be either located in a street or are concentrated in a bazar. Retail stores located in bazar usually offer a wider variety of edible oil.
- b) **Supermarket/Superstore (S):** a very large store (that can be part of a chain of stores) that sells a wide variety of goods.
- c) **Wholesaler/trader/importers (W):** an intermediary entity in the distribution channel that buys in bulk and sells to resellers rather than to the end consumers. In its simplest form, a distributor performs a similar role but often provides more complex services. Distributors and wholesalers often work together as channel partners. They are often located in or around bazars.

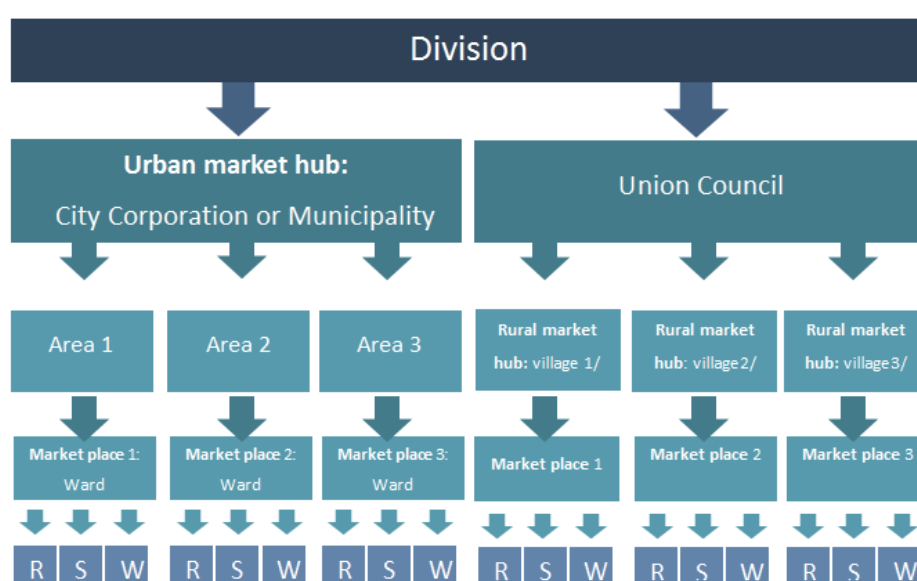


Figure 4 Selection of data collection sites in Bangladesh

Retail outlets of each retail outlet type (if available) were purposefully selected in each market place. An effort was made to select retail outlets with different supply chains where possible in order to maximize the variety of oil brands encountered. In rural settings where no supermarkets or wholesalers were available, more retail shops were visited in each marketplace to find a maximum of oil brands available in market. In urban areas, whenever possible, at least three retail outlets of each type were visited in each market place selected.

In each retail outlet visited, the name, location, and type of retail outlet were recorded on Form 1 (Annex 2 - Form 1: Marketplace and retail outlets selection). Information on the available brands per food vehicle, including the producer name and address, the distributor/importer name and address, and the packaging types and sizes for sale, was recorded on Form 2 (Annex 3 - Form 2: Brand Registration).

4.3 Collection of oil samples in the markets and analysis

4.3.1 Oil sample collection

Ten samples is a standard number used for most sampling schemes for a food category (Food and Agriculture Organization, 2018). The United States requires data for nutrition labelling to be based on 12 units. However, in concrete terms the required sample size depends on the variation of the micronutrients in the food.

In a brand or oil produced under the same conditions, the added micronutrient content is expected to be homogenous. The oil for which the average added micronutrient content will be measured is grouped into oil sampling units that have the same or similar production conditions (Holden, 1994); therefore, 10-12 samples are expected to be able to provide a good estimate of the true average.

To assess the compliance of brands produced under the same conditions, up to 12 samples were to be collected for each brand in each division. Brands that were available in more than one division were to be analyzed by division where available. Efforts were made to collect samples from different batches of production, as identified through production and expiration dates and/ or batch numbers. Whenever 12 samples could not be collected from different batches of production, samples were collected from different sized containers and from different retail outlets and market hubs to increase the likelihood to have diverse production conditions and time points while fulfilling the sampling quota.

Labelling of oil brands does not always provide all the information; therefore, samples from the three following scenarios were collected:

- Sealed packaging (packaged & labeled): Sealed containers labeled with brand name and producer information.
- Open packaging (labeled): packaging labeled with producer name or open packaging without label but where information on the producer can be identified by interviewing the vendor.
- Open packaging (unlabeled): open packaging without label. In some cases, unlabeled bulk oil could also be traced back to its origin (e.g. producer) by interviewing the retailers.

A minimum of 300-500 ml including open oil samples of each oil type was purchased. All samples were kept in the original packaging; except for the oil sold by weight or volume. Before taking the oil samples from an open oil container, the oil was stirred to ensure its homogeneity. Oil samples from large containers were transferred into clean, thick plastic containers with a tight cap to prevent leaking and cross-contamination. Each sample was labeled with a unique sample ID number to ensure its identification, as displayed below. The abbreviations used for the label codes are presented in Table 6.

DHD	023	B2	11
Division Code	Sample no. in division	Brand Code	Brand Sample

Table 6: Abbreviations of division names and edible oil types

Division Name		Edible Oil Type	
Barisal Division	BAD	Palm oil	PO
Chittagong Division	CHD	Soybean oil	SB
Dhaka Division	DHD	Sunflower oil	SF
Mymensingh	MYD	Canola/ Rapeseed oil	CO
Khulna Division	KHD	Rice bran oil	RB
Rajshahi Division	RJD	Super palm oil	SPO
Rangpur Division	RAD		
Sylhet Division	SYD		

The sample unique number, brand name, producer and production site, production and expiration dates, packaging type and size, price and if the package was labeled as fortified were documented on Form 3: Sample Registration (Annex 4 - Form 3: Sample Registration).



Figure 5: Labeled oil samples

The samples were then kept in black plastic bags that were placed in a cardboard box to ensure protection from sunlight, avoid contamination and guarantee good storage conditions until the composite samples were prepared. At the end of the data collection in all divisions, the samples were sent in their original packaging, except for open oil to the icddr,b office in Dhaka where the samples were kept in the dark at ambient temperature (25 ± 5 °C). The samples

were stored at icddr,b for 20 days before being sent to the icddr,b lab.

4.3.2 Determination of vitamin A content and fortification status of oil

Equal parts of each individual sample of the same brand and division were mixed to form a brand-specific composite sample for each division. Singles samples were warmed up to 40°C individually in an incubator for 30 minutes and shaken for 3 minutes to ensure homogeneity. Then, 50 ml of oil of each oil sample was aliquoted in a composite jar where a temperature of 40°C was maintained. This procedure was applied to each of the samples for each brand. The composite oil sample created was then stirred continuously for 20-30 minutes at 40°C using a stirring machine (Hotplate Stirrer MSH-20D, Daihan Scientific Co. Korea). Approximately 360 ml of the composite oil sample

was aliquoted into 3 different containers: one for the Vitamin A analysis at icddr,b, one for peroxide value testing at the nutritional biochemistry lab, of Bangladesh Council of Scientific and Industrial Research (BCSIR), and one for GAIN in case of any issues with any of the samples.

Each composite sample was labelled with a unique composite sample ID that includes the division code, the brand code and the composite sample number.

DHD	-	B2	-	11
Division Code		Brand Code		Composite Sample #

The list of the single samples included in each composite sample and their respective codes are available on Form 4: Sample Analysis (Annex 5 - Form 4: Sample Analysis).

The fortification status of the composite oil samples was determined by comparing the vitamin A content by brand to the mandated national standards stated in the *Fortification of Edible Oil with Vitamin A Act, 2013* (Table 7).

Table 7: Bangladesh Vitamin A and peroxide standards for fortification of edible oil

Standard	Micronutrient	Compound	Minimum content of addition	Maximum/ Safety Limits
Bangladesh standard 2013 BDS 1769: 2006, (1st Ed 08) BDS 1770: 2006, (1st Ed 08)	Vitamin A	Retinol Palmitate	0.015g/g (15 ppm)	0.030g/g (30ppm)
Bangladesh fortified soybean oil		Peroxide		5 mill equivalent oxygen per kg oil
Bangladesh fortified palm oil		Peroxide		8 mill equivalent oxygen per kg oil

The composite samples were tested for vitamin A content and the composite samples of the main brands were tested for both vitamin A content and POV. The analysis results were recorded on Form 5 (Annex 6 - Form 5: Sample Results).

The Nutrition Biochemistry Lab (NBL) conducted the vitamin A analysis using a high-performance liquid chromatographic (HPLC) to determine retinol content in oil samples. They followed AOAC Method No 960.45 AOAC 2001.13 Annexure-V. The NBL lab also measured POV content in oil using AOCS, 1998; Method No. Cd 8-53. AOAC 965.33- Annexure-III. Detailed laboratory procedures are available in Annex 7 - Laboratory analysis methods.

5 Results

lccdr,b teams visited a total of 553 retail outlets across the eight divisions. Table 8 presents an overview of the different retail outlet types visited in each division.

Table 8: Number of retail outlet types visited in each division

Division	Retail Outlet Type			Total
	Retail shop	Supermarket	Wholesaler	
Barisal	61	2	7	70
Chittagong	52	3	13	68
Dhaka	41	12	3	56
Khulna	76	2	13	91
Mymensingh	36	5	0	41
Rajshahi	103	5	3	111
Rangpur	42	1	1	44
Sylhet	58	4	10	72
National Total	469	34	50	553

A profile of Bangladesh's oil market

By country

Total

N = 97 packaged and labeled brands were found in the market in Bangladesh (representing about 35% of the market volume). In addition, 3 types of bulk oil: palm oil, and super palm oil were found (about 65% of the market volume)

Oil Types	N	%
Soybean oil	38	39
Rice bean oil	19	20
Sunflower oil	18	19
Palm oil	17	18
Vegetable oil (blend)	3	3
Canola oil	1	1
Super palm oil	1	1

By production origin

Local

N = 77 brands (79%) *

Oil types

Of the local brands, 37 are soybean oil, 18 are rice bran oil and 17 are palm oil. Other brands produced locally include: 2 sunflower oil, 2 blended oil brands, and 1 super palm oil brand.

Palm oil and soybean oil was sold as bulk in all 8 divisions, while bulk super palm oil was found in 7 divisions.

Production origin

Local brands are mainly produced in Dhaka (29 brands). Other production sites include Chittagong and Rajshahi (6 brands each), Khulna and Sylhet (5 brands each), Mymensingh (4 brands) and Rangpur (1 brand). Production sites of remaining brands are not known.

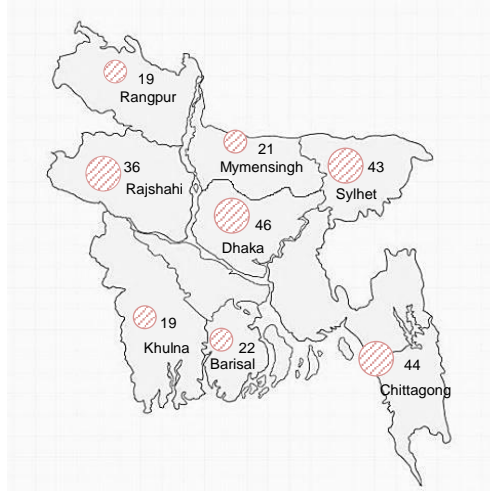
Outlets & market dispersion

Locally produced brands tend to be found in small retail shops (95% of local brands) and wholesalers (43%) more often than in supermarkets (35%).

The 6 main local brands were found across all 8 divisions (8%) while the majority of local brands are available in 3 or less divisions (75% of local brands). Bulk soybean oil, palm oil and super palm oil are produced locally and available in 7-8 divisions.

Packaging types*

Local brands are mostly sold in plastic bottles (92% of local brands), but a few are also available in sachets, jerry cans, metal tins and barrels. A majority of brands are available in 1L, 2L and 5L packaging and a few in 500ml. The majority of brands are sold in more than three sizes (55%) and a few are only available in one size (14%).



Imported

N = 21 brands (21%) *

Oil types

The majority of imported brands are sunflower oil (17 brands). The remaining brands (4) are evenly split between soybean oil, rice bean oil, blended oils and canola oil.

Production origin

The highest number of imported brands is produced in Turkey (3 brands) followed by Canada, Malaysia and Spain (2 brands each). Other imported brands come from India, Italy, the Netherlands, Oman and Ukraine (1 brand each). The origin of the remaining brands is not known.

Outlets & market dispersion

Imported brands tend to be found in retail shops (81% of imported brands) and supermarkets (76%). Only 29% are found in wholesalers.

Of the 21 imported brands, 1 main brand is sold across all 8 divisions (5%) and 1 brand was found in 6 divisions but the majority, 8 brands were available in just one division (38%).

Packaging types*

Imported brands are mostly available in plastic bottles (86% of imported brands). Packaging of 1L and 5L bottles is the most common (71% can be found both in 1L and 5L bottles). 2L and 3L bottles are also popular (62% are packaged in 2L bottles and 52% in 3L bottles). A few brands are also available in 1L, 2L, 3L or 5L jerry cans (43%). The majority of brands are found in more than three sizes (57%), although 6 brands are only found in one packaging size (29%).

*One of the brands available in the markets is produced both locally and imported from Malaysia while the brand label name is the same.

5.1 Availability/presence of edible oil brands

5.1.1 Brand availability/presence

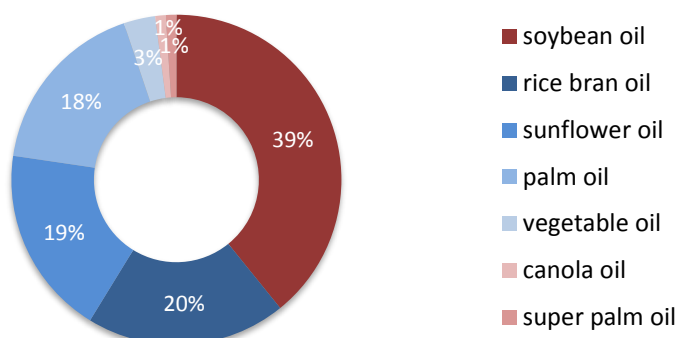
Brands are defined by the name stated on the label and the indicated oil type. In total, 100 different oils can be differentiated: 97 packaged and labeled oil brands and 3 different oil types sold as bulk: palm oil, soybean oil and super palm oil.

5.1.2 Availability/presence by oil types

According to the FAO, edible oils consumed in Bangladesh include 70% of palm oil, 20% of soybean oil, 6% of rapeseed oil and mustard oil, 1% of groundnut oil, 1% of coconut oil and 1% of rice bran oil (FAO, Food Balance Sheets 2013). A wide variety of edible oils was found in the market stalls visited.

Packaged and labeled brands comprised soybean oil (38 out of 97 brands), rice bran oil (19 brands), sunflower oil (18 brands) palm oil (17 brands) vegetable oil blends (3 brands), super palm oil (1 brand) and canola oil (1 brand). Table 5 shows an overview of the percentage of packaged and labeled brands available in markets by oil type.

Figure 6 Percentage of packaged and labeled brands available in markets by oil type (N=97)



Bulk oil

The following 3 types of oil are sold as bulk: palm oil, super palm oil and soybean oil and they are mostly produced by big manufacturing companies

5.1.3 Availability/presence by production origin

The majority of brands found in market are locally produced; 77 brands were produced in country and 21 brands were imported. One brand is both locally produced and imported and is therefore represented in each category.

Of the local brands found, 37 were soybean oil, 18 were rice bran oil and 17 were palm oil. Other brands produced locally include: 2 sunflower oil, 2 vegetable oil blends, and 1 super palm oil. A majority of local brands are produced in Dhaka (29 brands); other production sites include

Chittagong (6 brands), Rajshahi (6 brands), Khulna (5 brands), Sylhet (5 brands), Mymensingh (4 brands) and Rangpur (1 brand). Some local brands have no production origin information.

Of the 21 imported brands that were found, 17 brands were sunflower oil (81%). There were 1 canola oil brand and 1 vegetable oil brand produced in Canada, 1 rice bran oil brand produced in India, and sunflower brands imported from Turkey (3 brands), Malaysia (2 brands), Spain (2 brands), Italy (1 brand), Italy (1 brand), the Netherlands (1 brand), Oman (1 brand) and Ukraine (1 brand). Some imported brands have no production origin information. The production origin of locally produced and imported brands is displayed in Figure 7.

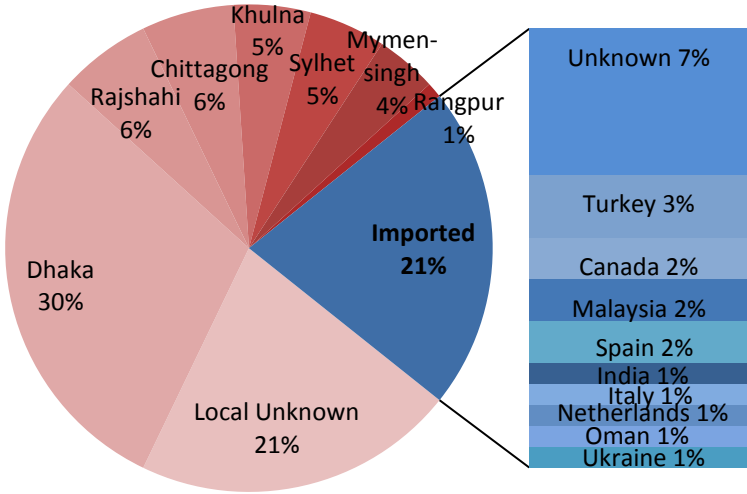


Figure 7 Production origin of locally produced (N=77) and imported brands (N=21)

5.1.4 Availability/presence by division

Seven oil brands from six different producers were available in all eight divisions of which only one was imported:

- BEOL
 - Fortune rice bran oil, India
 - Meizan palm oil, Bangladesh
 - Rupchanda soybean, Bangladesh
- Meghna Group
 - Fresh soybean oil, Bangladesh
- ACI Edible Oils
 - Nutrilife rice bran, Bangladesh
- T.K. Group
 - Pushti soybean oil, Bangladesh
- City Group
 - Teer soybean oil, Bangladesh

There was one oil brand that was present in seven divisions: ACI Group: ACI Pure soybean oil, Bangladesh. Most of the remaining brands were available in one division only (52 of 97 brands).

The largest variety of oil brands was found in Dhaka and Chittagong divisions with 46 and 44 brands, respectively. In Sylhet and Rajshahi there were 43 and 36 different oil brands found, respectively, while in the remaining divisions only 19 to 22 brands were found Figure 9 Number of packaged and labeled oil brands found in each division (Figure 9).

Bulk oil

Bulk palm oil and bulk soybean oil were found in all divisions and bulk super palm oil was found in all divisions except Rangpur.



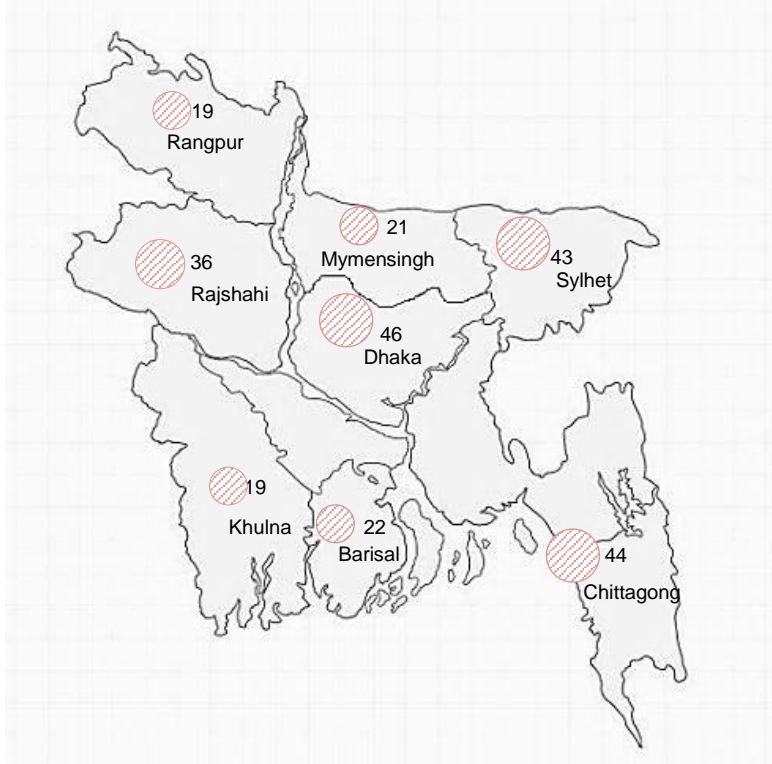
Figure 8: Oil supplier unloading edible oil barrels in a village located in Dhaka.

By origin

The 6 main local brands were found across all eight divisions (8% of local brands), 1 brand is available in seven divisions, 3 brands in six divisions, 4 brands were found in five divisions as well as four divisions, 5 brands in three divisions and 9 brands in two divisions. However, most brands were only available in one division (44 of 77 local brands). Most local brands were available in the following divisions: Chittagong (32 brands), Dhaka (28 brands) and Rajshahi (26 brands).

Of the imported brands, 1 brand was available across country, 1 brand was available in six divisions, 1 brand was present in five divisions, 4 brands were found in four divisions, 2 brands were available in three divisions and 4 brands were found in two divisions. Most imported brands (8 out of 21 imported brands) are only available in one division; either Dhaka or Chittagong. As for local brands, most imported brands were available in Dhaka (18 brands), Chittagong (13 brands) and Rajshahi (10 brands). There were only 2 imported brands found in Barisal and Khulna and only 1 imported brand in Rangpur.

Figure 9 Number of packaged and labeled oil brands found in each division



5.1.5 Availability/presence by retail outlet type

Most brands were available in retail outlets (89 out of 97 brands), while only about half of the brands were found in supermarkets (42 brands) and wholesalers (39 brands). In total, 24 brands were available in all three retail outlet types and 25 brands in 2 retail outlets.

By origin

Most local brands were found in retail outlets (73 of 77 of local brands), nearly half of brands were sold by wholesalers (33 brands) and a minority was available in supermarkets (27 brands).

Imported oil brands were mostly available in supermarkets (16 of 21 brands) and retail outlets (17 brands). There were very few imported brands found in wholesaler shops (6 brands). Figure 10 shows the percentage of local and imported brands available in each retail outlet type. The list of brands available by retail outlet type can be accessed in Annex 8 - Availability of brands per retail outlet.

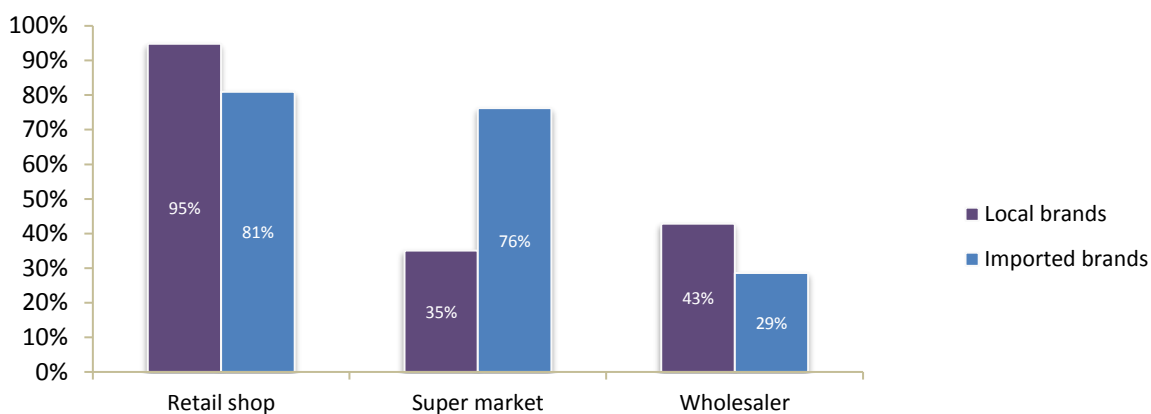


Figure 10 Percentage of local and imported brands available in each retail outlet type

Bulk oil

The three types of bulk oil were traded and sold in retail shops and wholesale shops, but none was available in supermarkets.

5.1.6 Availability/presence by price

Price of edible oil brands available across markets varies widely between oil types. The average oil price per liter across brands is BDT 143 ranging between BDT 72-450.

By oil type

Palm and super palm oil brands average price per liter is in the lower end with BDT 90. Average palm oil brands price per liter varies between BDT 72-113 with a coefficient of variation of 9%. Super palm oil price is only available for one brand. The average soybean oil brands price per liter is slightly higher than palm oil with BDT 102. Soybean oil brands price ranges between BDT 85-130 with a coefficient of variation of 7%.

Average price per liter of vegetable oil blends that are labelled either as “cooking oil” or “vegetable oil” is BDT 120 and it varies between BDT 90-180 with a coefficient of variation of 43%. Rice bran oil is in the middle price range with an average price per liter of BDT 127, ranging between BDT 107-200 and a coefficient of variation of 15%.

Sunflower oil and canola oil brands are the most expensive oil brands found in the market. The more expensive ones are imported. Sunflower oil brands average price per liter is BDT 274, ranging between BDT 216-435 and with a coefficient of variation of 19%. The most expensive brand found in the market is a canola oil brand marketed at BDT 450 per liter. Figure 11 displays the average brand price per liter by oil type. The table of each brand average price per liter is available in the Annex 9 - Brand average price per liter.

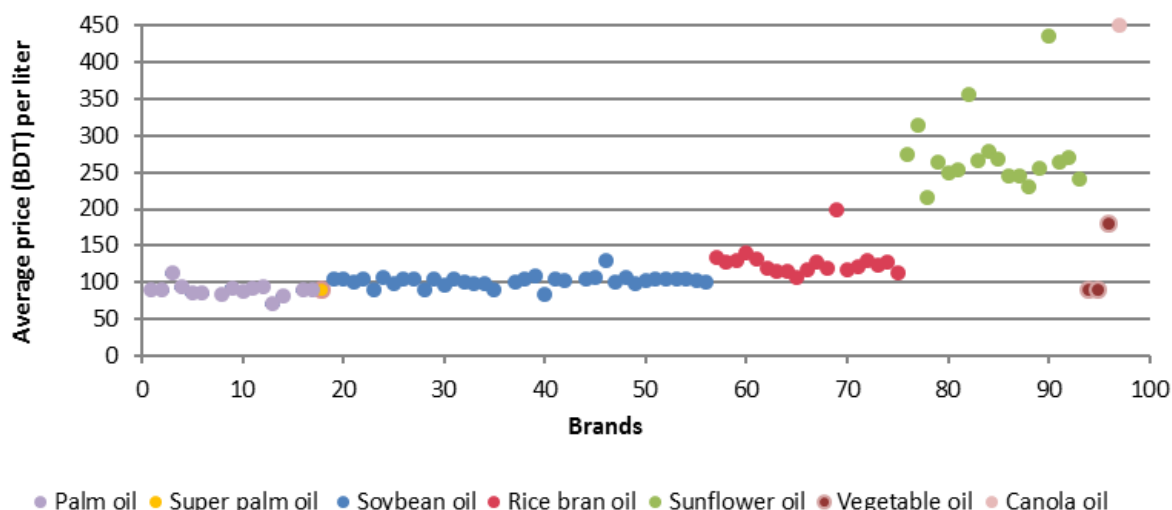


Figure 11 Brand average price (BDT) per liter per oil type

Bulk oil

Oil sold as bulk is situated in the lower price range with an average price per liter of BDT 85 (BDT 82-86). Bulk palm oil is the cheapest with an average price of BDT 82 with a coefficient of variation of 6%, super palm oil average price is BDT 86 with a coefficient of variation of 6% and finally, bulk soybean oil costs BDT 88 per liter on average with a coefficient of variation of 7%.

5.1.7 Availability/presence by packaging and labelling

Most packaged brands available in market stalls are packaged in plastic bottles (93%). A few brands are sold in jerry cans (18%) and a small percentage is sold in sachets and metal tins (8% each) or barrels (5%). Most brands are packaged in 1L (72%), 2L (63%) and/ or 5L (66%) containers. Containers of 500ml (40%) and 3L (27%) are less common and other sizes like 4L (7%), 8L (12%) and 10L (2%) are rarer.

By origin

Most local brands are packaged in plastic bottles (92% of local brands) of 500ml (38% of local brands), 1L (57%), 2L (49%) and 5L (51%). A few local brands are packaged in jerry cans and sachets (8% each), metal tins (6%) or barrels (5%). The majority of brands are sold in more than three sizes (55%) and a few are only available in one size (14%).

Imported brands available in markets are also mostly packaged in plastic bottles (86% of imported brands). Some of them are packaged in jerry cans (43%) and a few in metal tins (10%). Imported brands were neither found in sachets nor in barrels. More than half of the imported oil brands are available in 1L (71%), 2L (62%), 3L (52%) and 5L (71%) packaging. Most brands are found in more than three sizes (57%), although 6 brands are only found in one packaging size (29%).

Bulk oil

All types of bulk oil can be found in barrels of 180-210L. Palm oil and soybean oil are also available in plastic bottles; metal tins and jerry cans and super palm oil can be found in plastic bottles and metal tins.

5.1.8 Availability/presence in rural and urban areas

Availability of brands was also assessed in terms of their presence in urban and rural markets. Of the 97 packaged oil brands, 61 brands were only available in urban areas (63%) and 8 brands were only available in rural markets (8%). The 7 main brands that were available across all divisions were found in rural and urban areas as well. The list of brands available in the CCs, MCs and UCs visited can be consulted in: Annex 10 - List of brands available in CC, MC and UC.

By oil type

Rice bran and sunflower oil brands seem to be less available in rural markets. Of the 19 rice bran oil brands, 12 were only found in urban markets (63%) and of the 18 sunflower oil brands available, 16 were only available in urban areas (89%). Of the 17 palm oil brands, 8 are only available in urban areas (47%) and of the 38 soybean oil brands, 20 were only available in urban market stalls (53%). Canola oil, super palm oil and vegetable oil blend brands were only found in urban markets. In contrast, 2 palm oil brands were only found in rural areas (12%) and 7 soybean oil brands (18%) were only found in rural stalls.

Bulk oil

The three types of bulk oil are available in both rural and urban areas.

By country

Total

N = 66 packaged brands analyzed (1414 single samples collected across the 8 divisions of Bangladesh and mixed into 168 composite samples). In addition, 3 types of bulk oil were assessed: soybean oil, palm oil and super palm oil. 492 single samples were collected in all divisions for palm and soybean oil and 5 divisions for super palm oil and mixed into 41 composite samples.

By type of packaging

Packaged and labeled oil

N = 66 brands (defined by name of brand and oil type)

Overall brands

Of the packaged brands, 26 were not fortified (39%), 12 brands were fortified below the standard minimum (18%), and 28 brands were fortified above the standard minimum (43%).

Oil types

All of the sunflower oil analyzed, 87% of rice bran oil brands, about half of the soybean oil, vegetable oil and palm oil brands are fortified.

Divisions

Most brands were fortified above the standard minimum in all divisions: Khulna (73%), Rangpur (64%), Rajshahi (61%), Dhaka (60%), Barisal (57%), Sylhet (47%), Mymensingh (46%) and Chittagong (45%).

Production origin

Of the 66 brands analyzed, 4 brands were imported and all of them were fortified above the minimum standard range. Of the local brands (62 brands), 25 brands were not fortified, 11 brands were fortified below the standard minimum, 3 brands were slightly under and 25 brands were fortified above the standard minimum.

Fortification labels

Most of the packaged brands are labeled with the fortification logo or statement (60 out of 66 brands). Of the brands that had the fortification logo or statement, 22 brands were not fortified (37%) and of the brands without any fortification mention on their label, 2 brands were fortified (33%).

Urban and rural areas

In cities (CCs), towns (MCs) and villages (UCs) over two thirds of the available brands assessed were fortified. 53% of the 45 brands available in CCs, 26% of the 51 brands available in MCs, and 57% of the 30 brands available in UCs were fortified above the standard minimum.

Market volume

The estimated market volume of packaged oil brands represents about 35% of the market volume: 69% of packaged market volume is fortified above standard minimum and 5% is not fortified.

Bulk and unbranded oil

N = 41 bulk oil composite samples analyzed by oil type and division

Oil types

9 composite samples of bulk palm oil (69%), 10 of soy bean (50%) and 5 of super palm oil (63%) were not fortified. 4 composite samples of bulk palm oil (31%), 10 of soybean (50%) and 3 of super palm oil (37%) were fortified, but only 1 composite sample of soybean oil and 2 composites of bulk super palm oil were fortified above the standard minimum.

Divisions

Bulk palm oil was not fortified in 5 divisions and traces of vitamin A were found in 3 divisions. Bulk super palm oil was not fortified in 2 divisions and partially fortified in 2 other divisions and fortified above the standard minimum in 1 division. Bulk soybean oil was not fortified in 2 divisions and fortified below standard in 6 divisions.

Production origin

Oil sold as bulk is all produced locally.

Fortification labels

Oil sold as bulk is not labelled; therefore, there is no fortification logo or statement.

Urban and rural areas

Fortification status of bulk oil types available in the three areas: CC, MC and UC were similar.

Market volume

The estimated market volume of bulk oil brands makes up about 65% of the market volume: Based on the fortification status proportion of the composite samples and the estimated market volume by oil type, 59% of bulk oil sold is not fortified, 34% is fortified below standard and 7% is fortified above standard minimum.

5.2 Compliance analysis

This section presents the content of fortification with vitamin A of brands analyzed by the laboratory and if they meet the national fortification standards. The peroxide value content of the main brands was also analyzed to assess the oxidative rancidity to verify that the quality of the edible oil at retail level is not an issue.

The *Bangladesh Fortification of Edible Oil with Vitamin A Act, 2013* was used to review vitamin A content of oil brands for compliance with Vitamin A standards. The following cut-offs for “in”, “above” and “under” range of standards were used (Table 9).

Table 9 Oil fortification standards cut-offs for Vitamin A and peroxide value

Comparison to standard	Under range	In range	Above range
Vitamin A	≤ 15 ppm	15-30 ppm	> 30 ppm
Peroxide soybean oil	-	≤ 5 meq oxygen/kg	> 5 meq oxygen/kg
Peroxide palm oil	-	≤ 8 meq oxygen/kg	> 8 meq oxygen/kg

For all other oil types, we apply the peroxide standard values of soybean oil.

5.2.1 Oil sample collection

Among 97 brands available in markets, samples from 66 brands were collected and analyzed. In total 1906 samples were collected in the eight divisions across country and 1414 single samples were compiled to composites for analysis. Up to 12 single samples by brand and division were mixed to form 168 composite samples. For the main 7 brands, 12 single samples of the brand were collected in each division where it was available. Due to limited availability of many brands less than 12 samples were collected for 37 brands and only one sample was collected for 18 brands. For 31 brands, no samples were taken. Annex 13 - Brand composite and single samples analyzed per division shows the number of samples and composites per brand.

In addition, 492 single samples of bulk palm oil, super palm oil and soybean oil were collected. Twelve single samples per oil type were collected in each division per oil type and producer where possible and mixed to form 41 composite samples.

5.2.2 Quality control tests for Vitamin A and peroxide value

5.2.2.1 Vitamin A

Quality control (QC) tests for vitamin A were carried out during analysis by including oil samples spiked with a known concentration of Vitamin A. One quality control sample spiked with a precise vitamin A content (5.1 or 9.9 mg/kg) was introduced and analyzed every 10th sample. Spiked samples were prepared by an independent laboratory and checked internally. The detailed preparation method of the QC samples is available in the Annex 7 - Laboratory analysis methods.

Quality control results during the analysis showed a recovery rate of 35%⁴ and a coefficient of variation (CV) of 4%. The measurement uncertainty (MU) was calculated at 73%.⁵ When comparing to the fortification standard we considered that the true vitamin A content lies in the range of $\pm 73\%$ around the lab result. To correct for the systematic error (bias), the lab applied a correction factor of 2.86 to all results which reduced the MU to 8%. Detailed calculations can be found in the Annex 11 - QC results and correction factor. QC samples analysis results with HPLC are presented in Figure 12. The results of the analysis are displayed in red and the lab results with the correction factor are displayed in blue.

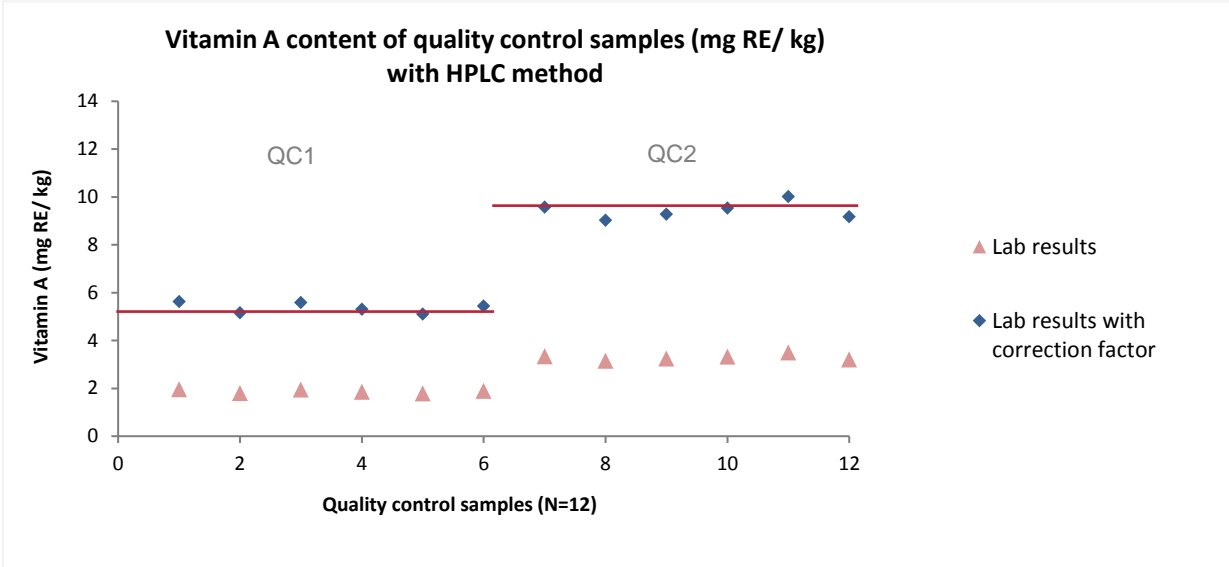


Figure 12 Vitamin A content (mg RE/kg) of spiked samples analyzed with HPLC

Red solid lines indicate the spiked sample mean. Quality control 1 (QC1) is spiked with 5.1 mg RE /kg (samples 1-6) and quality control 2 (QC2) is spiked with 9.9 mg RE /kg (samples 7-12).

Spiked QC samples were re-analyzed with icheck to confirm the vitamin A content. The results obtained with the icheck method are presented in Figure 13.

⁴ Bias = 65% (100% - recovery rate)
⁵ MU formula = Bias + 2*CV = (100%-35%) + 2*4%

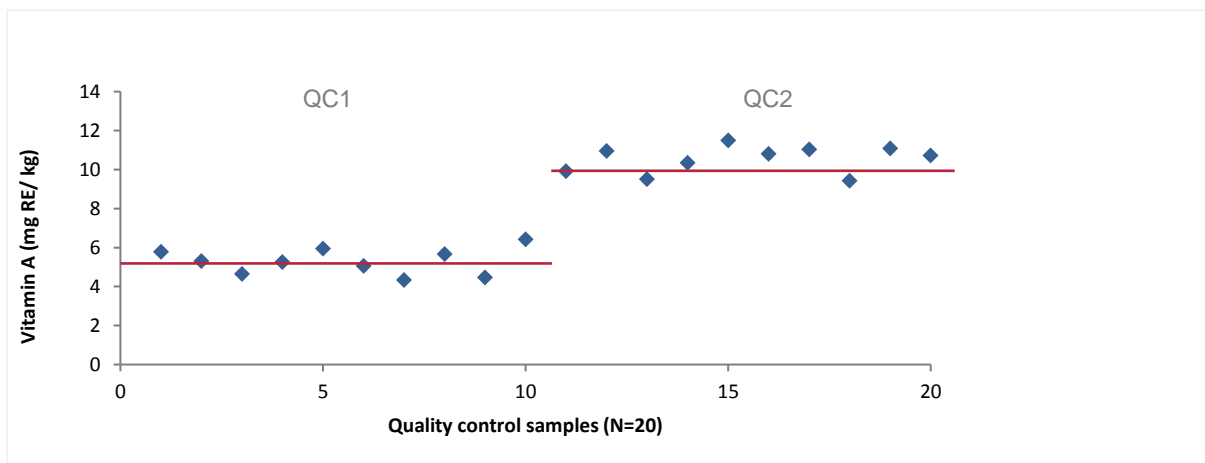


Figure 13 Vitamin A content (mg RE/kg) of spiked quality control (QC) samples analyzed with icheck

Red solid lines indicate the spiked sample mean. Quality control 1 (QC1) is spiked with 5.1 mg RE /kg (samples 1-10) and quality control 2 (QC2) is spiked with 9.9 mg RE /kg (samples 11-20).

5.2.2.2 Peroxide value

Vitamin A degradation in oil is associated with lipid peroxidation. Peroxide content was analyzed for the main oil brands to determine the degree of oxidation that could reduce vitamin A content. Quality control results for peroxide showed a CV of 8%. When comparing to the standard we considered that the true value lies in the range of $\pm 16\%$ around the lab result (95% confidence level).

5.2.3 Vitamin A content and fortification status by brand

The lab analyzed the average vitamin A content of 66 packaged and labeled brands. The average vitamin A content of each brand was compared to the standard. Twenty-six brands were not fortified (39%) and 40 brands were fortified (61%). The average vitamin A fortification content by brand are displayed in Figure 14. The lab results without and with the correction factor are displayed for comparison.

Based on the laboratory results without the correction factor 13 brands were fortified above the standard minimum (20%) (I.e. average vitamin A content is above the legal minimum set by the national fortification standard), while based on the corrected results, 28 brands were fortified above standard minimum (42%).

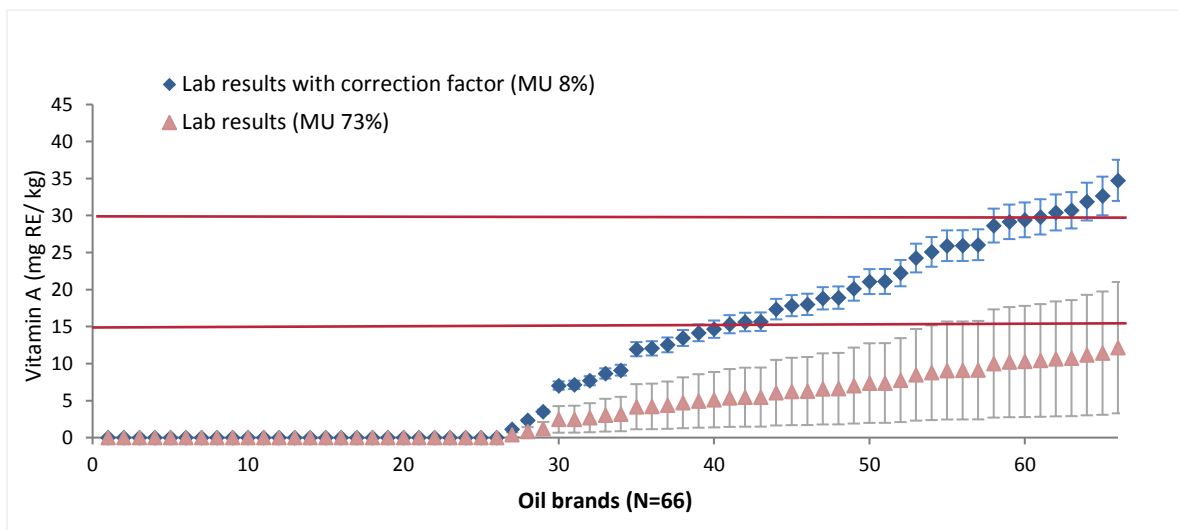


Figure 14 Vitamin A content (mg RE/ kg) by brand using HPLC with and without the correction factor

Red solid lines indicate the mandatory fortification range according to the most recent national standards (15-30 mg RE/ kg) for oil. Error bars indicate the measurement uncertainty $\pm 73\%$ for lab results and $\pm 8\%$ for lab results with correction factor.

The subsequent results will only present the corrected lab results.

Based on the corrected lab results, 28 brands (42%) were fortified above minimum standard and 26 brands were not fortified (39%). The average vitamin A content of 12 brands was below the standard minimum (18%), of which 4 brands (6%) were fortified slightly below standard minimum (i.e. the average vitamin A content was less than 20% below the standard minimum).

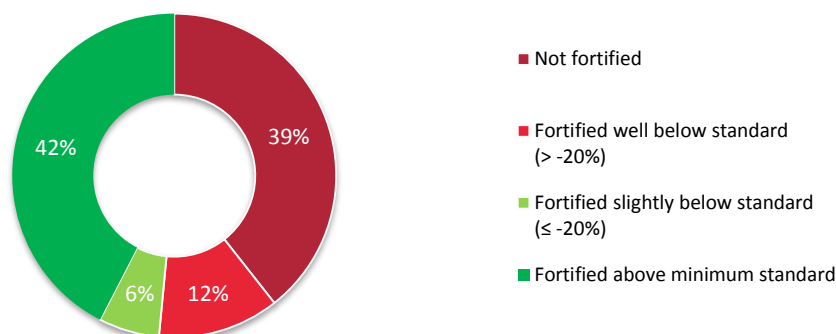


Figure 15 Percentage of vitamin A fortification status of packaged oil brands (N=66)

Not fortified = Vitamin A not determined, fortified below standard = vitamin A content $< 15\text{mg RE/kg}$, fortified slightly below standard minimum = average vitamin A content less than 20% below the standard minimum, fortified well below standard minimum = average vitamin A content over 20% below the standard minimum.

Figure 16 shows the distribution of composite results analyzed for the same brand for which multiple single samples were collected in more than one division (N=22). The mean value is displayed in blue and the composite sample vitamin A results are displayed in green.

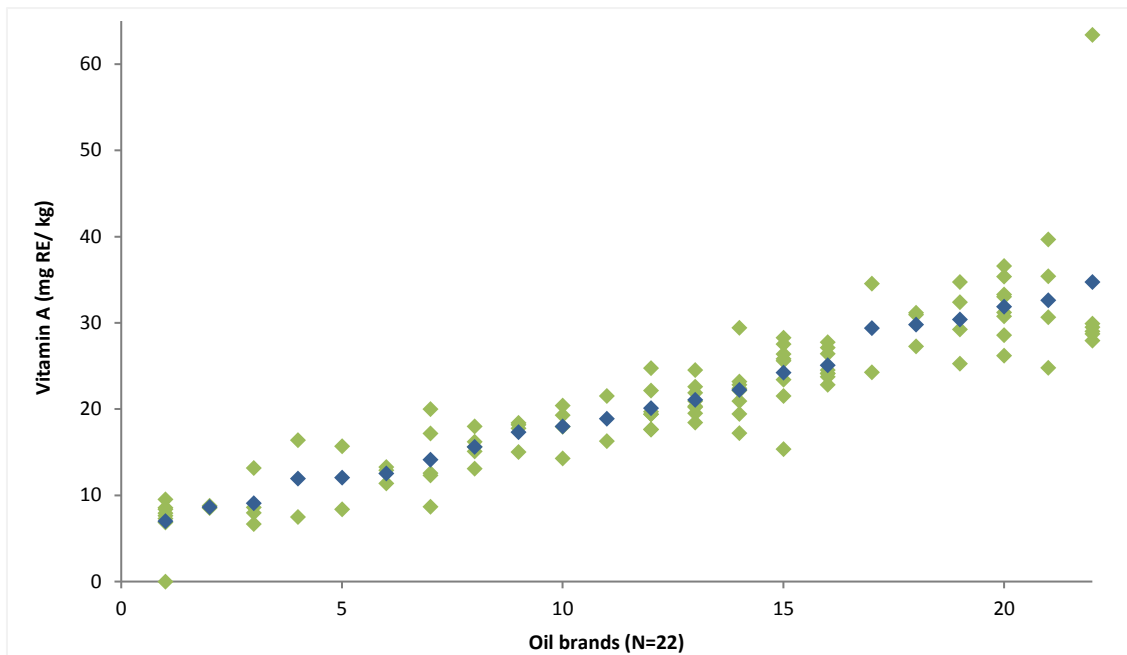


Figure 16 Brand vitamin A content (mg RE/kg) distribution

The mean value is displayed in blue and the composite sample vitamin A results are displayed in green.

Bulk oil

In total, 41 composite samples of unbranded bulk oil were analyzed. Fifty-nine percent of all the bulk composite samples were not fortified and about another third was fortified below the standard. Seven percent of the bulk oil composite samples were fortified above the standard minimum (Figure 17).

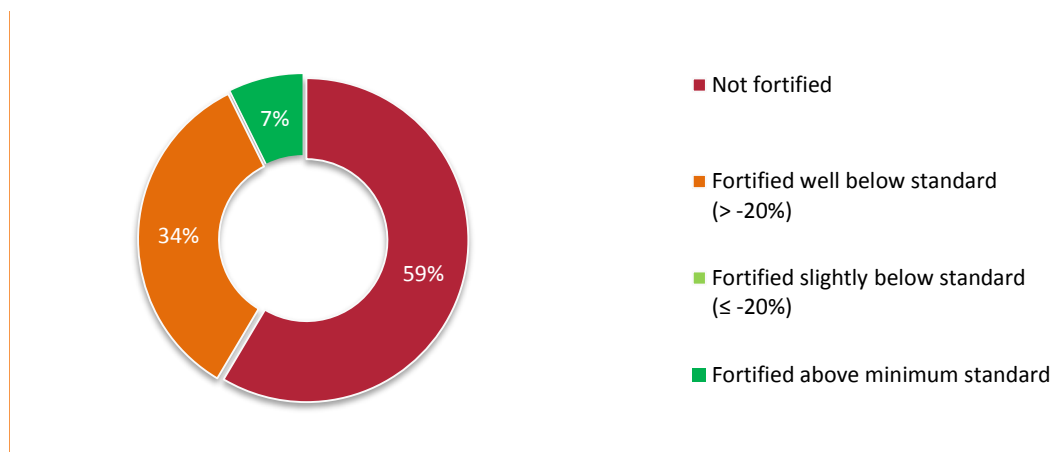


Figure 17 Fortification status of composite samples of bulk oil (N=41)

Not fortified = Vitamin A not determined, fortified below standard = vitamin A content <15mg RE/kg, fortified slightly below standard minimum = average vitamin A content less than 20% below the standard minimum, fortified well below standard minimum = average vitamin A content over 20% below the standard minimum.

5.2.4 Vitamin A content and fortification status by oil type

Packaged oil

Fortification status by oil type show that 7 of 15 palm oil brands were fortified (47%), 6 of them above the standard minimum (40%); 13 of 15 rice bran oil brands were fortified (87%), 11 of them above the standard minimum (73%); 17 of 31 soybean oil brands were fortified (55%), 8 of them above the standard minimum (26%); all 3 sunflower oil brands were fortified, 1 brand was fortified slightly below the standard minimum (i.e. the average vitamin A content was less than 20% below the standard minimum) and 2 brands were fortified above the minimum range (67%). One of the 2 brands of vegetable oil was fortified above the standard minimum (50%) while the other one was not fortified. Presentation by oil type is displayed in Figure 18.

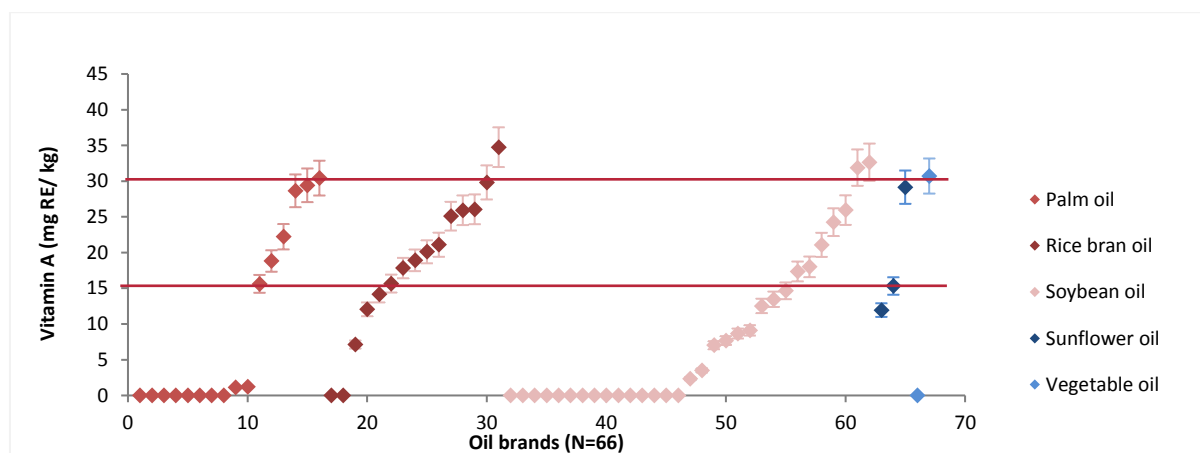


Figure 18 Brand vitamin A fortification content (mg RE/kg) per oil type

Solid lines indicate the mandatory fortification range according to the most recent national standards (15-30 mg RE/kg) for oil. Error bars indicate the measurement uncertainty ($\pm 8\%$).

Bulk oil

In total, 13 composite samples of palm oil, 20 composites of soybean oil and 8 composites of super palm oil were collected and analyzed. 9 composite samples of bulk palm oil were not fortified (69%) and 4 composite samples were fortified well below standard minimum (31%) (i.e. the average vitamin A content was more than 20% below the standard minimum). 5 composite samples of super palm oil were not fortified (62.5%), 1 composite sample was fortified well below standard (12.5%) and 2 composite samples were fortified above minimum standard (25%). 10 composite samples of soybean oil were not fortified (50%) and 9 composite samples were fortified well below (45%), and 1 composite was fortified above the standard minimum (5%).



Figure 19 Fortification status of composite samples of bulk palm (PO), soybean (SB) and super palm oil (SPO)

Not fortified = Vitamin A not determined, fortified below standard = vitamin A content <15mg RE/kg, fortified slightly below standard minimum = average vitamin A content less than 20% below the standard minimum, fortified well below standard minimum = average vitamin A content over 20% below the standard minimum.

5.2.5 Fortification status of brands available by division

Figure 20 displays an overview of the fortification status of available packaged brands per division. Most brands were fortified above minimum standard in Khulna (73% of brands), Rangpur (64%), Rajshahi (61%), Dhaka (60%) and Barisal (57%). More than a third of brands were not fortified in Sylhet (38%) and Dhaka (35%) and more than a third of the available brands were fortified below minimum standard in Mymensingh (38%).

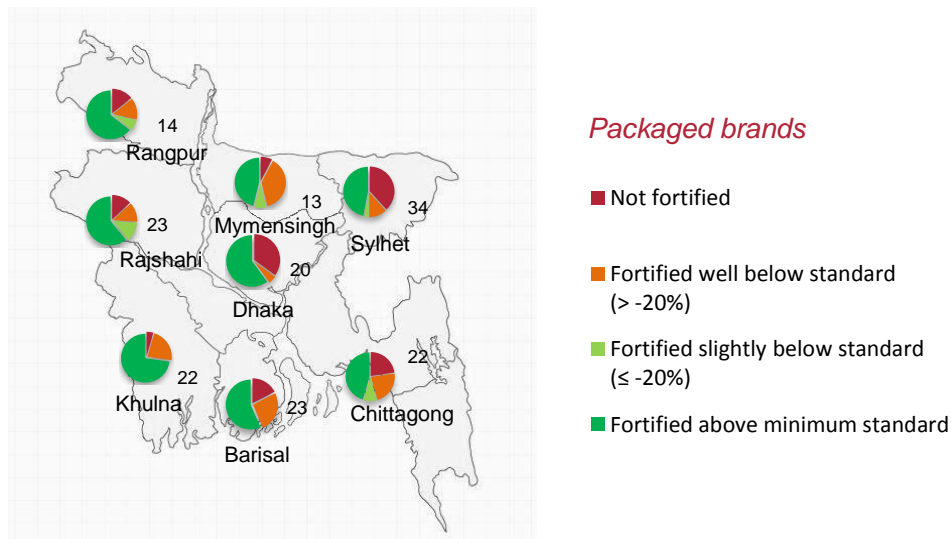


Figure 20 Number of packaged brands analyzed and fortification status proportion per division

Not fortified = Vitamin A not determined, fortified below standard = vitamin A content <15mg RE/kg, fortified slightly below standard minimum = average vitamin A content less than 20% below the standard minimum, fortified well below standard minimum = average vitamin A content over 20% below the standard minimum.

Bulk oil

None of the three bulk types collected in Dhaka were fortified. In Rajshahi, palm oil and super palm oil sold as bulk were not fortified while bulk soybean oil contained traces of Vitamin A. In Mymensingh and Rangpur bulk palm oil was not fortified, bulk soybean oil was partially fortified, while in Sylhet, bulk palm oil was partially fortified and bulk soybean oil was not. Super palm oil brands were not analyzed in any of these three divisions. In Barisal, bulk soybean and bulk super palm oil were partially fortified while bulk palm oil was not. In Chittagong and Khulna, the three types of bulk oil were partially fortified.

Bulk palm oil was not fortified in 5 out of 8 divisions and traces of vitamin A were found in 3 divisions (38%). Bulk super palm oil was tested in 5 divisions and was not fortified in 2 and was fortified below the standard in 2 other divisions and fortified above the standard minimum in 1 division. Bulk soybean oil was not fortified in 2 out of 8 divisions and fortified below standard in 6 divisions. The overview of the number and fortification status of composite samples per division and oil type is presented in Figure 21.

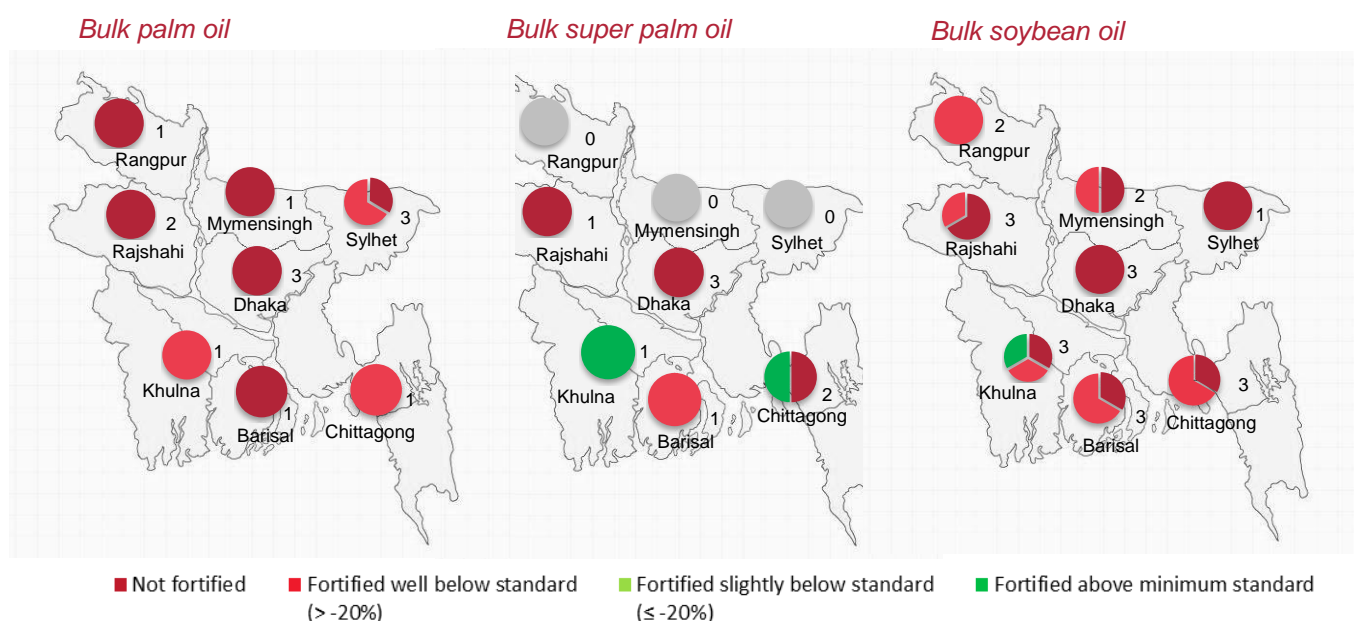


Figure 21 Number of bulk oil composite samples analyzed and fortification status per division and oil type

Not fortified = Vitamin A not determined, fortified below standard = vitamin A content <15mg RE/kg, fortified slightly below standard minimum = average vitamin A content less than 20% below the standard minimum, fortified well below standard minimum = average vitamin A content over 20% below the standard minimum.

5.2.6 Vitamin A content and fortification status by origin of production

Of the 66 packaged oil brands analyzed, 4 brands were imported and 62 brands were produced in-country. All the imported brands analyzed were fortified above the minimum standard range. Of the brands produced locally, 25 brands were not fortified (40%). Of the brands fortified, 11 brands were fortified below standard range (18%) of which 3 brands were fortified slightly below standard

minimum (i.e. the average vitamin A content was less than 20% below the standard minimum), and 25 brands were fortified above minimum standard (40%). The average fortification content by origin of production are represented in Figure 22.

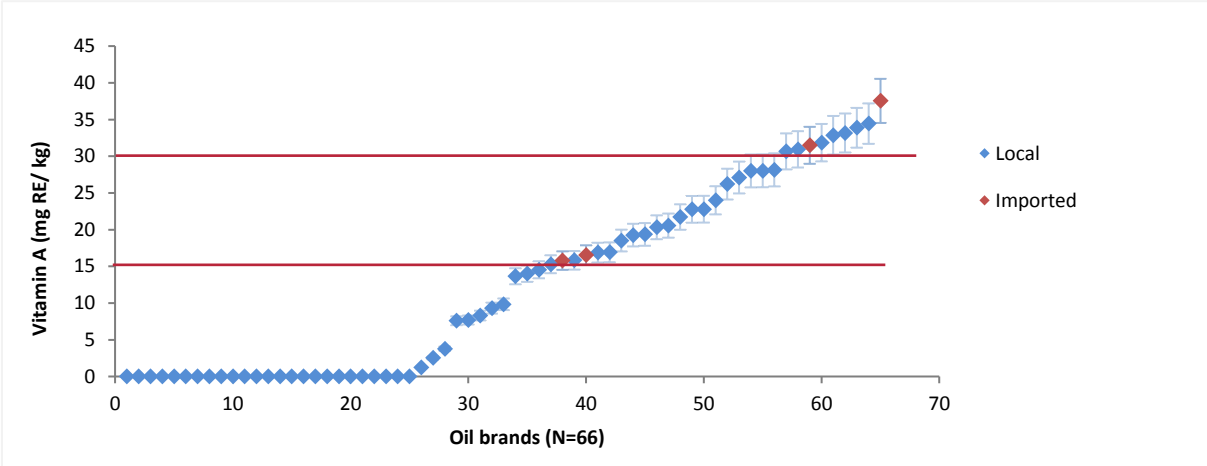


Figure 22 Brand vitamin A content (mg RE/kg) per origin (N=66)

Solid lines indicate the mandatory fortification range according to the most recent national standards (15-30 mg RE/kg) for oil. Error bars indicate the measurement uncertainty ($\pm 8\%$).

5.2.7 Vitamin A content and fortification status by package labeling

The fortification by package labeling shows that of the 66 oil brands analyzed for vitamin A content, the majority were labeled with a fortification logo or statement (60 brands). Of the brands with a fortification logo or statement, 22 brands were not fortified (37%) and 38 brands were fortified (63%) of which 25 brands were fortified above the standard minimum (42%). Of the 6 brands that did not have any fortification logo or statement on their label (9%), 4 of them were not fortified (66%) and 2 were fortified (33%), of which one was fortified above the minimum standard range (17%) as displayed in Figure 23.

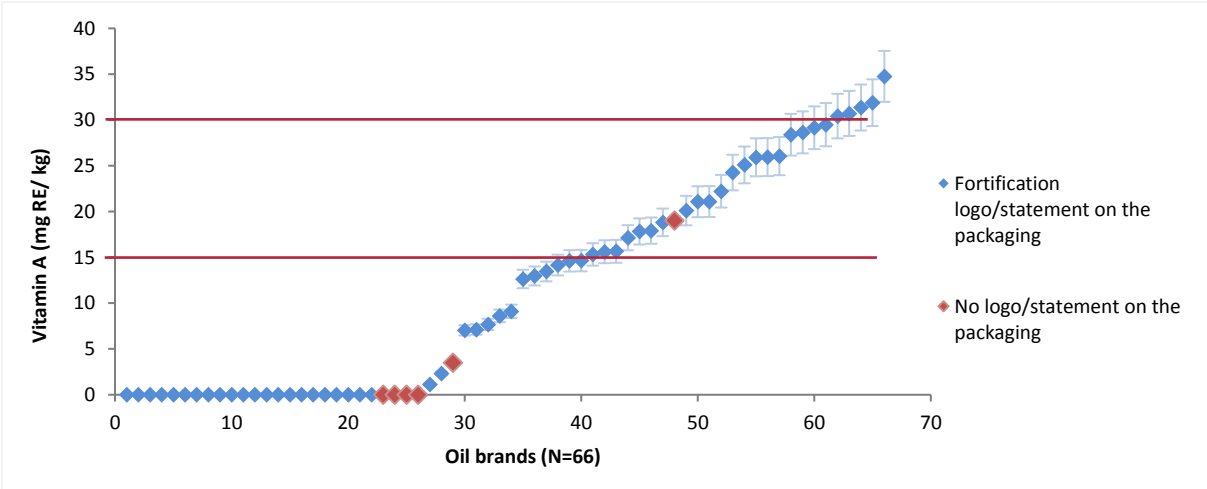


Figure 23 Brand vitamin A fortification content (mg RE/kg) per package labeling

Red solid lines indicate the mandatory fortification range according to the most recent national standards (15-30 mg RE/ kg) for oil. Error bars indicate laboratory measurement uncertainty ($\pm 8\%$).

5.2.8 Fortification status of brands available in urban and rural areas

In each division availability of brands was collected in urban areas: city corporation (CC) and town (MC),⁶ and in rural areas: in three villages (UC). Of the 45 brands that were available in CCs (urban), 71% were fortified and 53% above the standard minimum. Of the 51 brands that were available in MC (urban), 68% were fortified and 26% above the standard minimum. Of the 30 brands that were available in UC (rural), 77% were fortified and 57% above the standard minimum. The fortification status of the brands available in CC, MC and UC are presented in Figure 24.

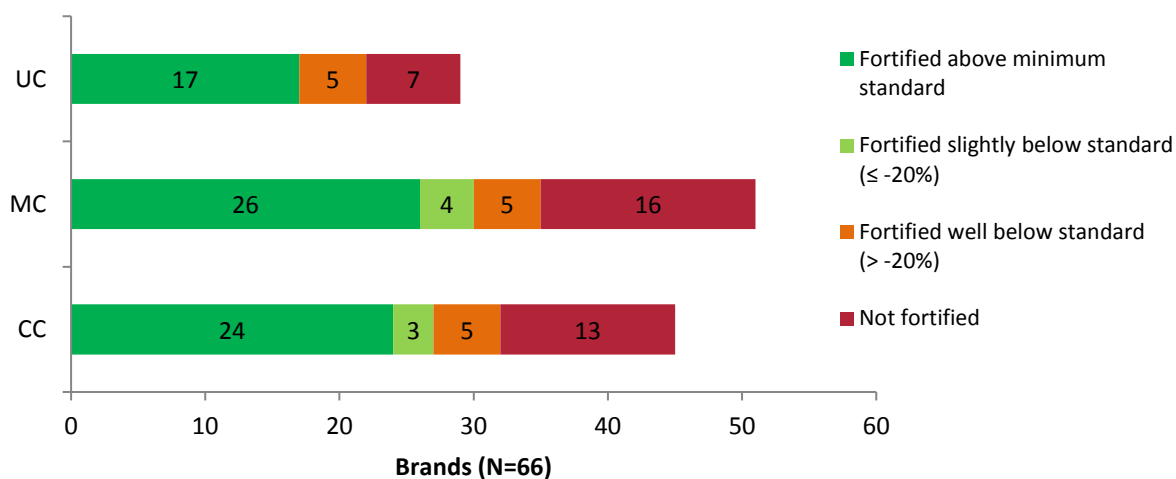


Figure 24: Fortification status of brands per city corporation (CC), town (MC) and villages (UC)

Not fortified = Vitamin A not determined, fortified below standard = vitamin A content $< 15\text{mg RE/kg}$, fortified slightly below standard minimum = average vitamin A content less than 20% below the standard minimum, fortified well below standard minimum = average fortification content over 20% below the standard minimum.

5.2.9 Fortification status by market volume

Market volumes are estimated to assess the fortification status regarding the edible oil market volumes they represent and to give a better idea of the potential coverage of households.

The market volume of edible oils in Bangladesh is estimated at 2.6 million MT based on domestic consumption estimates for 2016/17 (United States Department of Agriculture, 2017) from which palm oil and soybean oil make up about 2.4 million MT (Global Agricultural Information Network, 2017).

⁶ Except in Mymensingh where there is no CC and where two MCs were visited.

Packaged oil

The 97 packaged oils brands that were found in the market represent about 35% (900,000 MT) of the market volume based on the production volumes reported by producers. For smaller brands for which no volumes were reported we assigned the same average volume as for similarly available brands with known volume. The main 66 packaged oils brands for which the fortification status was analyzed correspond to about 34% of the market volume. Figure 25 displays the fortification status percentage of the assessed market volumes based on the 66 packaged brands analyzed. In total, 5% of the market volume of the assessed packaged brands is not fortified, 27% is fortified below the standard minimum, of which 12% is fortified slightly below the standard (i.e. average vitamin A content over 20% below the standard minimum), and 69% is fortified above the standard minimum.

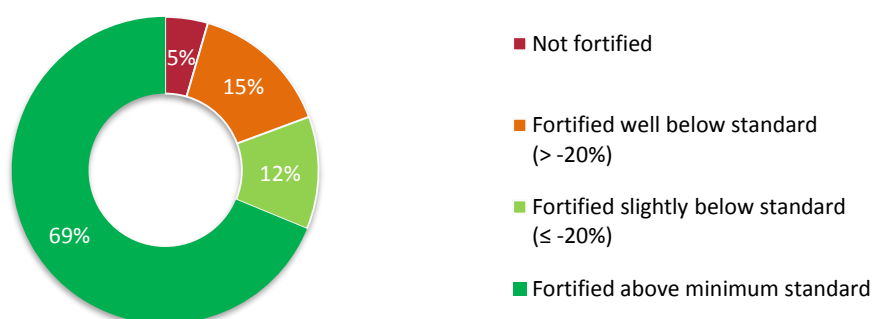


Figure 25 Fortification status of the assessed market volume of packaged and labeled brands

Not fortified = Vitamin A not determined, fortified below standard = vitamin A content <15mg RE/kg, fortified slightly below standard minimum = average vitamin A content less than 20% below the standard minimum, fortified well below standard minimum = average vitamin A content over 20% below the standard minimum.

Bulk oil

Market volume of oil sold as bulk is estimated to be about 65% of the total market volume. Three types of bulk oil were assessed: palm oil, super palm oil and soybean oil. Bulk palm oil dominates the bulk market (Global Agricultural Information Network, 2017). Palm oil and super palm oil account for 70% of the total volumes and soybean oil for 30% of the volumes. We estimate that the ratio of super palm oil to palm oil is 1:1.5. The fortification status proportion of the bulk have been estimated based on the proportions of each bulk oil type in the total bulk oil market. More than half of the bulk oil is not fortified (60%), nearly one third is fortified well below standard (34%) (i.e. average vitamin A content over 20% below the standard minimum), and 7% is fortified above the standard minimum. The fortification status of bulk oil available in markets is presented in Figure 26.

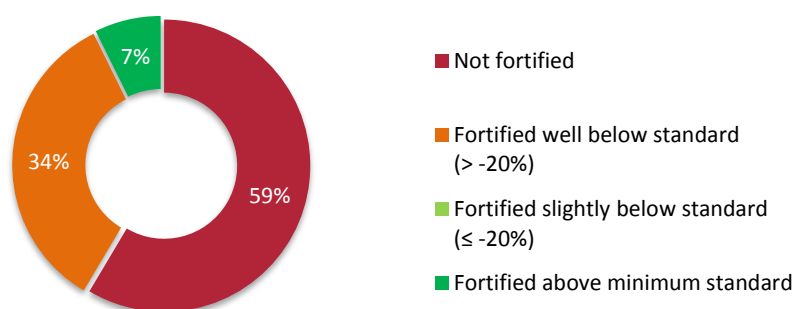


Figure 26 Fortification status of the assessed market volume of bulk oil

Not fortified = Vitamin A not determined, fortified below standard = vitamin A content <15mg RE/kg, fortified slightly below standard minimum = average vitamin A content less than 20% below the standard minimum, fortified well below standard minimum = average vitamin A content over 20% below the standard minimum.

Packaged and bulk oil

The fortification status of the assessed market volumes (99% of 2,600,000 MT) for both packaged and bulk oil shows that over half of oil volume (59%) available in Bangladesh is fortified and about a third (27%) is fortified above the standard minimum (see Figure 27). This is higher for packaged oil (which has a lower market share) of which 95% was fortified (69% above minimum standard), compared with bulk oil 41% of which was fortified (7% above minimum standard).

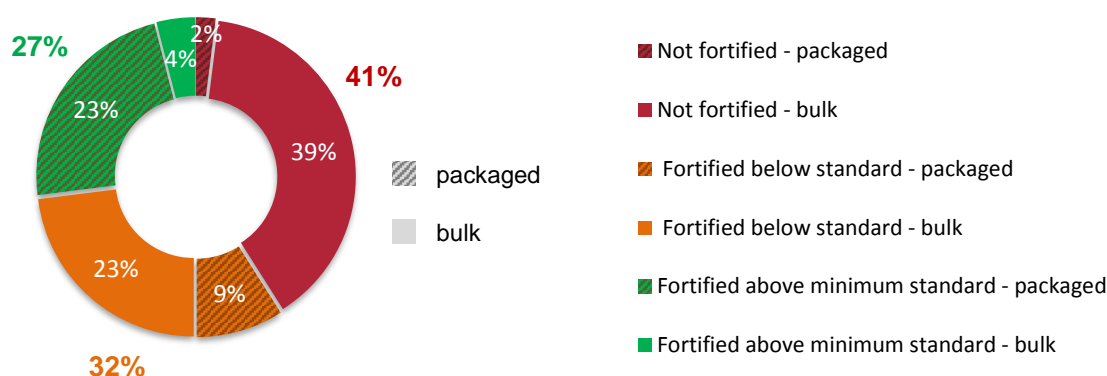


Figure 27 Fortification status of the assessed market volume of packaged and bulk oil

Not fortified = Vitamin A not determined, fortified below standard = vitamin A content <15mg RE/kg, fortified slightly below standard minimum = average vitamin A content less than 20% below the standard minimum, fortified well below standard minimum = average vitamin A content over 20% below the standard minimum.

5.2.10 Peroxide content analysis

The laboratory analyzed the peroxide content of 21 main brands and all of them were below the maximum POV as set by the standard. The average peroxide content across brands is 1.82 meq oxygen/kg while the maximum content is 3.87 meq oxygen/kg.

6 Conclusion and recommendations

The findings of this survey fill a critical information gap on the presence of oil brands sold in urban and rural markets in all 8 divisions of Bangladesh and their vitamin A content.

As part of this study, 553 retail outlets including retail shops, supermarkets and wholesalers were visited. Ninety-seven packaged oil brands were found. 77 of these were locally produced (79%) and 21 were imported brands (21%). Eight were identified as main brands found in seven or even all 8 divisions of Bangladesh, while 64 brands were found in 2 divisions or less. Three types of oil were sold as bulk; palm oil, soybean oil and super palm oil. Bulk palm and soybean oil was sold in all divisions visited, while super palm oil was found in 7 of 8 divisions.

For the 66 main packaged oil brands, oil samples from different batches or retail outlets were taken and analyzed for nutrient content of vitamin A and compared to the national fortification standards.; Based on the average fortification status of brands, 26 brands were found not to be fortified (39%), 40 oil brands were fortified (61%) and 28 of them above the standard minimum. More than a third of local brands were not fortified (40%) while all imported brands analyzed were fortified above the standard minimum range.

Packaged brands included in the assessment represent about 35% of the market volume. Only about 5% of the packaged oil market volume is not fortified and more than two thirds of the assessed packaged oil supply is fortified above the standard minimum. The main brands that make up a large proportion of the packaged oil are fortified above the minimum of the fortification standard. However, smaller refineries do not seem to fortify their brands.

Three oil types are sold as bulk and make up about 65% of the edible oil market volume in Bangladesh and about two-thirds of bulk oil is estimated not to be fortified as per the standard requirements, about one third is fortified below standard and less than 10% is fortified above the standard minimum range. The main local oil companies that fortify their packaged brands also produce oil sold as bulk. Bulk oil is assumed to be predominantly consumed by lower income populations due to the lower prices and because it can be purchased in smaller amounts.

Fortification status of assessed market volumes for packaged and bulk oil taken together shows that about two thirds of oil available in Bangladesh is fortified and only about a third is fortified above the minimum standard.

The study findings highlight that the main locally produced and imported packaged brands are fortified above the minimum of the fortification standard, but fortification of smaller locally produced brands and oil sold as bulk need to be improved.

The following recommendations can be made to improve the availability of adequately fortified oil brands in markets:

1. The largest volumes of oil are sold to the population as bulk palm oil. Oil sold in bulk, mainly palm oil and soy bean oil, is only partially fortified or fortified at content far below the fortification requirements. Oil producers and refineries should be made accountable for fortification of bulk oil by ensuring traceability of their production. Mandatory fortification law also applies to bulk oil; therefore, inspections of the fortification of producers/suppliers of bulk oil needs to be prioritized and appropriate labeling to make oil traceable and fortification reinforced by BSTI. Packaging and handling of bulk oil may need to be reviewed to ensure that the vitamin A content of bulk oil is maintained until it reaches the consumer.
2. Presumably due to the lower price and the ability to buy bulk oil in small quantities, a large proportion of the population consumes unbranded/unlabeled bulk oil. The oil refineries should reconsider making the bulk oil available in small packaging sizes.
3. Behavioral change intervention can encourage mass population to choose packaged and labeled fortified oil;
4. BSTI should prioritize inspections of producers that were identified not to fortify their oil to ensure corrective action. A dedicated cell should be developed to inspect the refineries on a regular basis. The inspection currently focuses mainly on the analysis of results but not on the overall quality assurance mechanism of edible oil fortification. Inspection the fortification process of the producers can identify issues in a timely manner and ensure consistent production of fortified oil.
5. Local NGO's, Consumer Association of Bangladesh (CAB), Local government and other should provide support to local producers to enable them to supply traceable and fortified oil, particularly of oil currently sold as bulk.
6. Fortification standards should provide further information on the target average vitamin A content that oil should have when it is accessed and consumed by the consumer and the specify what variation has been included in the acceptable range set.
7. Quality control with spiked samples (known content) should always be included in the analysis of results to identify laboratory result variation.
8. Compiling and updating market volumes to estimate the magnitude of available fortified oil/foods and potential coverage can be improved.

9. Market assessments of availability and fortification content of oil provide valuable information to regulatory authorities and fortification program management and can identify major bottle necks and provide guidance to prioritize inspections and corrective action at key monitoring content (e.g. production, import). Responsible regulatory authorities should undertake market assessments on a regular basis to get an overview of the oil available and the fortification status of oil on the market.

10. With further research on the consumption and coverage of different oil brands and bulk oil types in different population groups potential additional micronutrient intake and reduction of their micronutrient gaps can be assessed.

These results will be shared with nutrition stakeholders in the country to further guide programming efforts and nutrition policy recommendations.

Annexes

Annex 1 - Market hubs selection in each division

	Division	Division Populat.- Census 2011	District	District Populat. Census 2011	CC	CC Populat. Census 2011	Sub-district with largest population	Sub-district Populat. Census 2011	MC with largest populat. in each sub-district	MC Populat. Census 2011	UC name with largest population in each sub-district	UC Populat. Census 2011	
District 1 - CC District 2 - MC and UC	Barisal	8,325,666	Barisal	2,324,310	Barisal CC	328,278	Barisal Sadar	527,017			Ulania	51,077	
	Barisal	8,325,666	Bhola	1,776,795			Char Fasson	456,437	Char Fasson	19,595	Illisha	46,924	
	Barisal	8,325,666	Jhalokati	682,669			Jhalokati Sadar	216,348			Rajapur	34,399	
	Barisal	8,325,666	Patuakhali	1,535,854			Galachipa	361,518			Golkhali	32,169	
	Barisal	8,325,666	Pirojpur	1,113,257			Mathbaria	262,841			Purba Deulbaridobra	40,601	
	Chittagong	28,423,01	Bandarban	388,335			Lama	108,995			Alikadam	28,495	
	Chittagong	28,423,01	Brahmanbaria	2,840,498			Brahmanbaria Sadar	521,994			Sarail	46,927	
	Chittagong	28,423,01	Chandpur	2,416,018			Chandpur Sadar	465,919			Tamta Dakshin	47,983	
	Chittagong	28,423,01	Chittagong	7,616,352	Chittagong CC	2,581,64	Patiya	528,120			Hathazari	74,565	
	District 1 - CC District 2 - MC and UC	Chittagong	28,423,01	Comilla	5,387,288						222,676	Uttar Durgapur	54,913
Chittagong		28,423,01	Cox's Bazar	2,289,990			Chakoria	474,465			Sabrang	58,358	
Chittagong		28,423,01	Feni	1,437,371			Feni Sadar	512,646			Panchgachhiya	43,468	
Chittagong		28,423,01	Khagrachhari	613,917			Matiranga	126,477			Merung	39,989	
Chittagong		28,423,01	Lakshmipur	1,729,188			Lakshmipur Sadar	684,425			Char Gazi	42,890	
Chittagong		28,423,01	Noakhali	3,108,083			Begumganj	549,308			Chandnandi	80,509	
Chittagong		28,423,01	Rangamati	595,979			Rangamati Sadar	124,728			Sajek	27,568	
District 1 - CC		Dhaka	36,433,50	Dhaka	12,043,97	Dhaka North CC	3,773,00	Savar	1,385,91			Dhamsana	308,024
		Dhaka	36,433,50	Faridpur	1,912,969			Faridpur Sadar	469,410			Kanaipur	48,559
		Dhaka	36,433,50	Gazipur	3,403,912			Gazipur Sadar	1,820,37			Gachha	253,512
	Dhaka	36,433,50	Gopalganj	1,172,415			Gopalganj Sadar	344,008			Maheshpur	31,012	

	Dhaka	36,433.50	Kishoreganj	2,911.907		Kishoreganj Sadar	414.208		Chauddasata	40,873	
	Dhaka	36,433.50	Madaripur	1,165.952		Madaripur Sadar	345.764		Khalia	34,986	
	Dhaka	36,433.50	Manikganj	1,392.867		Manikganj Sadar	309.413		Dhalla	36,203	
	Dhaka	36,433.50	Munshiganj	1,445.660		Munshiganj Sadar	383.263		Panchasar	78,312	
	Dhaka	36,433.50	Narayanganj	2,948.217		Narayanganj Sadar	1,323.60		Kutubpur	259,262	
	Dhaka	36,433.50	Narsingdi	2,224.944		Narsingdi Sadar	707.525		Putia	54,503	
	Dhaka	36,433.50	Rajbari	1,049,778		Rajbari Sadar	331,631		Nawabpur	37,879	
	Dhaka	36,433.50	Shariatpur	1,155.824		Bhedarganj	253.234		Idilpur	37,641	
District 2 - MC and UC	Dhaka	36,433.50	Tangail	3,605.083		Tangail Sadar	521.104	Tangail	167.412	Arankhola	59,895
District 1 - MC (no CC)	Mymensingh	10,990.91	Mymensingh	5,110.272		Mymensingh Sadar	775.733	Mymensingh	258.040	Habirbari	98,605
District 2 - MC and	Mymensingh	10,990.91	Jamalpur	2,292.674		Jamalpur Sadar	615.072	Jamalpur	142.764	Pogaldigha	53,002
	Mymensingh	10,990.91	Netrokona	2,229.642		Netrokona Sadar	372.785		Kalmakanda	47,852	
	Mymensingh	10,990.91	Sherpur	1,358,325		Sherpur Sadar	497.179		Pakuria	37,340	
	Khulna	15,687.75	Bagerhat	1,476.090		Bagerhat Sadar	294.576		Kara Para	34,127	
	Khulna	15,687.75	Chuadanga	1,129,015		Chuadanga Sadar	345.922		Uthali	49,007	
District 2 - MC and UC	Khulna	15,687.75	Jessore	2,764.547		Jessore Sadar	742.898	Jessore	201.796	Noapara	54,878
	Khulna	15,687.75	Jhenaidah	1,771.304		Jhenaidah Sadar	455.932		Kazirber	32,941	
District 1 - CC	Khulna	15,687.75	Khulna	2,318.527	Khulna CC	663.342	Dumuria		Jalma	59,025	
	Khulna	15,687.75	Kushtia	1,946.838		Kushtia Sadar	305.675		Hogalbaria	48,263	
	Khulna	15,687.75	Magura	918.419		Magura Sadar	502.255		Talkhari	34,920	
	Khulna	15,687.75	Meherpur	655.392		Gangni	380.107		Amjhupi	54,586	
	Khulna	15,687.75	Narail	721.668		Narail Sadar	299.607		Peruli	28,297	
	Khulna	15,687.75	Satkhira	1,985.959		Satkhira Sadar	272.872		Agardari	37,654	
District 2 - MC and	Rajshahi	18,484.85	Bogra	3,400.874		Bogra Sadar	460.892	Bogra	400.983	Garidaha	48,511
	Rajshahi	18,484.85	Joypurhat	913.768		Joypurhat Sadar	555.014		Bhadra	35,015	
	Rajshahi	18,484.85	Naogaon	2,600.157		Naogaon Sadar	289.058		Mahadebpur	39,948	
							405.148				

	Rajshahi	18,484.85	Natore	1,706.673			Natore Sadar	442.422		Nagar	42,175	
	Rajshahi	18,484.85	Chapai				Shibganj			Durlabhpur	56,011	
	Rajshahi	18,484.85	Nawabgani	1,647.521			Pabna Sadar	591.178		Dogachhi	84,015	
	Rajshahi	18,484.85	Pabna	2,523.179			Baghmara	590.914		Matikata	45,118	
District 1 - CC	Rajshahi	18,484.85	Rajshahi	2,595.197	Rajshahi CC	448.087	Shahjadpur	354.664		Daulatpur	88,236	
	Rajshahi	18,484.85	Sirajganj	3,097.489			Dinajpur Sadar	561.076	Dinajpur	186.727	Auliapur	46,925
District 2 - MC and UC	Rangpur	15,787.75	Dinajpur	2,990.128			Gobindaganj	484.597		Ballamjhar	47,620	
	Rangpur	15,787.75	Gaibandha	2,379.255			Ulipur	514.696		Bandaber	52,413	
	Rangpur	15,787.75	Kurigram	2,069.273			Lalmonirhat Sadar	395.207		Tushbhandar	48,014	
	Rangpur	15,787.75	Lalmonirhat	1,256.099			Nilphamari Sadar	333.166		Dimla	45,574	
	Rangpur	15,787.75	Nilphamari	1,834.231			Panchagarh Sadar	435.162		Mallikadaha	29,140	
	Rangpur	15,787.75	Panchagarh	987.644			Rangpur Sadar	271.707		Tapodhan	52,487	
District 1 - CC	Rangpur	15,787.75	Rangpur	2,881.086	Rangpur CC	795.556	Rangpur Sadar	718.203		Ruhea	37,410	
	Rangpur	15,787.75	Thakurgaon	1,390.042			Thakurgaon Sadar	581.227		Gazipur	35,167	
	Sylhet	9,910.219	Habiganj	2,089.001			Nabiganj	345.179		Sreemangal	55,078	
	Sylhet	9,910.219	Maulvibazar	1,919.062			Kulaura	360.195		Jamalganj	51,604	
District 2 - MC and UC	Sylhet	9,910.219	Sunamganj	2,467.968			Chhatak	397.642	Chhatak	44.364	Khadim Para	88,793
District 1 - CC	Sylhet	9,910.219	Sylhet	3,434.188	Sylhet CC	479.837	Sylhet Sadar	829.103				

Annex 2 - Form 1: Marketplace and retail outlets selection

MARKET PLACES AND RETAIL OUTLETS BY DIVISION					1	Date of interview (dd/mm/yyyy)	____ / ____ / 2017	Name of interviewer:	
Division abbrev.	Division name	Name of City corporation/ Paurashava / Union council	Urban/ Rural	Area code (A1,A2,A3)	Ward / Village Name	Retail outlet type 1 R: Retail shop; S: Supermarket; W: Wholesaler, trader, importer.	Retail outlet type 2 R: Retail shop; S: Supermarket; W: Wholesaler, trader, importer.	Retail outlet type 3 R: Retail shop; S: Supermarket; W: Wholesaler, trader, importer.	

Annex 4 - Form 3: Sample Registration

SAMPLE REGISTRATION FORM				FOOD VEHICLE		VEGETABLE OIL		Date of interview (dd/mm/yyyy)		____ / ____ / 2017		3				
DIVISION		DIVISION CODE*		Name of interviewer:												
Sample No. * (use for label)	Brand	Type of oil	Name of Producer	Localization of production site (city)	Brand sample No. *	Sample ID * (as in the label)	City Corp/ Munic/ Union Coun. (CC, MN, UC)	Name of Ward/Village	Retail outlet type (R, S, W)	Production date	Expiry date	Batch number	Labeled as fortified? Y=Yes (Statement), L = Yes (Logo), N = no	Packaging type (Plastic bottle, jerry can, tin)	Packaging size (Liter)	Unit cost (Taka) If barrel: cost/liter
1					B1-01											
2					B1-02											
3					B1-03											
4					B1-04											
5					B1-05											
6					B1-06											
7					B1-07											
8					B1-08											

Annex 5 - Form 4: Sample Analysis

SAMPLE ANALYSIS FORM				4	
Division code	Single sample No.	Brand sample No. *	Single Sample ID *	Composite Sample No.	Composite Sample ID *
				001	

Annex 6 - Form 5: Sample Results

SAMPLE RESULTS FORM								5
Composite sample ID *	Laboratory Composite sample ID *	Vitamin A			POV			
		Average vitamin A content in available oil (____ per kilo)	Range - including measurement Uncertainty (± ____%)	Reference/standard comparison (15-30 g/kg) [in, under or over]	Average POV content (meq/Kg) AOAC - 965.33	Range - including measurement Uncertainty (± ____%)	Reference/standard comparison (<5 meq/Kg) [in, under or over]	

Annex 7 - Laboratory analysis methods

The composite samples created were tested for Vitamin A and POV content.

Vitamin A Analysis using HPLC

The Nutrition Biochemistry Lab (NBL) conducted the Vitamin A analysis using a high-performance liquid chromatographic (HPLC) procedure to determine retinol content in oil samples. They followed AOAC Method No 960.45 AOAC 2001.13 Annexure-V.

Icddr,b signed an MOU with The Institute of Food Science and technology (IFST) which is the largest national Research and Development organization which conducts research in the field of food science and technology. The collected oil sample with appropriate labeling (blinded without brand/ company name) was transferred to Oil seed and Lipid technology section of IFST for analysis.

On the basis of existing lab facilities and analysis cost, Nutrition Biochemistry Lab (NBL) was chosen for Vitamin A analysis. A high-performance liquid chromatographic (HPLC) procedure was used for the determination of retinol in oil samples. The methodology for oil retinol is given below:

Oil retinol will be measured by High performance liquid chromatography (HPLC). Oil samples will be saponified with alcoholic KOH and then extracted into hexane. The hexane layer will be transferred to a clean glass vial, evaporated under nitrogen, re-dissolved in mobile phase. An aliquot of that injected onto a C18 reversed phase column and isocratically eluted with a mobile phase. The chromatograms will be monitored by a UV-detector at wavelength 325 nm. These chromatograms will be recorded by computer data system (LC Solution). Concentration will be calculated by comparison of peak areas of retinol in test samples with those of standards using a standard curve.

Preparation of 2 spiked Quality control samples

Preparation of the stock solution by BioAnalyt and checked internally:

Stock solution 1 (Target concentration 3000 mg RE/kg): 0.9004g retinol palmitate (Sigma-aldrich; order number PHR1235-1G) and 164.1g rapeseed oil (Fluka Analytical; order number 83450-500ml) were mixed at 6 rpm in a dark bottle for 18 hours.

33 000 IU/Kg sample (=10 mg RE/kg):

3,3333g of stock solution 1 (3 000 mg RE/kg) was completed with rapeseed oil to total 1 kg and mixed at a shaking frequency of 100 /min in a dark bottle for 18 hours.

Dilution factor = $1000g/3.3333g = 300.003$ (DF)

$3\ 000\ \text{mg RE/kg} / 300.003\ (\text{DF}) = 9.9999\ \text{mg RE/Kg}$

$1\ \text{mg RE} = 3\ 300\ \text{IU}$, i.e. $9.9999\ \text{mg RE/kg} \times 3\ 300\ \text{IU/kg} = 32\ 999.67\ \text{IU/kg}$

17 000 IU/Kg sample (=5.151515 mg RE/kg):

1.7172g of stock solution 1 (3 000 mg RE/kg) was completed with rapeseed oil to total 1 kg and mixed at a shaking frequency of 100 /min in a dark bottle for 18 hours.

Dilution factor(Gesamtgewicht/ Einwaage)= $1000g/1.7172g = 582.343$ (DF)

$3\ 000\ \text{mg RE/kg} / 582.343\ (\text{DF}) = 5.1516\ \text{mg RE/Kg}$

$1\ \text{mg RE} = 3\ 300\ \text{IU}$, i.e. $5.1516\ \text{mg RE/kg} \times 3\ 300\ \text{IU/kg} = 17\ 000.28\ \text{IU/kg}$

Peroxide Value

The lab also measured Peroxide Value (POV) content in oil using AOCS, 1998; Method No. Cd 8-53. AOAC 965.33- Annexure-III.

Purpose: This testing method is to explain step by step procedure for determination of peroxide value of oil or fat and the samples containing oils and fats.

Scope: This method is applicable to all edible fats and oils or sample containing fats & oils.

Principle: The peroxide value is a measure of the peroxides contained in the fat or oil. During storage, peroxide formation is slow at first during an induction period, which may vary from a few weeks to several months according to the particular oil or fat, temperature and storage conditions etc.

This value is determined by the reaction of potassium iodide in acid solution with the bounded oxygen followed by titration of the liberated iodine with sodium thiosulphate.

APPARATUS

1. Balance capable of weighing to the nearest 0.1 mg.
2. 250 ml. glass stoppered Erlenmeyer flasks.
3. 10 ml Class B Burette, graduated in 0.05 divisions, with a tolerance of ± 0.04 ml.
4. Mohr pipette capable of containing 1 ml with a tolerance of ± 0.04 ml.
5. 2-graduated cylinders capable of containing 50 ml.
6. Dispensing device, capable of dispensing 1 ml.

REAGENTS AND SOLUTIONS

1. Acetic Acid - chloroform solution (480ml Acetic Acid and 320ml Chloroform).
2. Saturated Potassium Iodide solution. Store in the dark.
3. Sodium thiosulfate solution, 0.1N. Commercially available.
4. 1% Starch solution. Commercially available.
5. Distilled or deionized water.

PROCEDURE

Conduct a blank determination of the reagents daily.

1. Weigh 5.00 (± 0.05)g of sample into a 250 ml glass stoppered Erlenmeyer flask. Record weight to the nearest 0.01g.
2. By graduated cylinder, add 30 ml of the acetic acid - chloroform solution.
3. Swirl the flask until the sample is completely dissolved. Using 1 ml Mohr pipette, add 0.5 ml of saturated potassium iodide solution.
4. Stopper the flask and swirl the contents of the flask for exactly one minute.

5. Immediately add by graduated cylinder, 30 ml of either distilled or deionized water, stopper and shake vigorously to liberate the iodine from the chloroform layer.
6. Fill the burette with 0.1N sodium thiosulfate.
7. If the starting color of the solution is deep red orange, titrate slowly with mixing until the color lightens. If the solution is initially a light amber color, go to step 9.
8. Using a dispensing device, add 1 ml of starch solution as indicator.
9. Titrate until the blue gray color disappears in the aqueous (upper layer). Note: for Doe-120, titrate until the lower layer has a "milky" appearance.
10. Accurately record the mls of titrant used to two decimal places.

CALCULATIONS

S = titration of sample

B = titration of blank

Peroxide value = $(S - B) \times N \text{ thiosulfate} \times 1000$

weight of sample

or $(S - B) \times N \text{ thiosulfate} \times 200$

Annex 8 - Availability of brands per retail outlet type

Brand code	Oil Type	Origin	Retail shop	Supermarket	Wholesaler	Number of retail types where brand is available
GBD196	SF	Imported	yes	yes	yes	3
GBD193	SF	Imported	yes	yes	yes	3
GBD123	SF	Imported	yes	yes	yes	3
GBD023	RB	Imported	yes	yes	yes	3
GBD002	SB	Local	yes	yes	yes	3
GBD008	RB	Local	yes	yes	yes	3
GBD010	RB	Local	yes	yes	yes	3
GBD026	PO	Local	yes	yes	yes	3
GBD030	SB	Local	yes	yes	yes	3
GBD033	SB	Local	yes	yes	yes	3
GBD048	SB	Local	yes	yes	yes	3
GBD057	RB	Local	yes	yes	yes	3
GBD061	RB	Local	yes	yes	yes	3
GBD069	RB	Local	yes	yes	yes	3
GBD087	RB	Local	yes	yes	yes	3
GBD096	SB	Local	yes	yes	yes	3
GBD102	SB	Local	yes	yes	yes	3
GBD104	PO	Local	yes	yes	yes	3
GBD132	RB	Local	yes	yes	yes	3
GBD141	RB	Local	yes	yes	yes	3
GBD168	PO	Local	yes	yes	yes	3
GBD172	RB	Local	yes	yes	yes	3
GBD174	SB	Local	yes	yes	yes	3
GBD178	RB	Local	yes	yes	yes	3
GBD046	PO	Local	yes		yes	2
GBD197	SF	Imported	yes		yes	2
GBD189	VO	Imported	yes	yes		2
GBD139	SF	Imported	yes	yes		2
GBD131	SF	Imported	yes		yes	2
GBD120	SF	Imported	yes	yes		2
GBD089	SF	Imported	yes	yes		2
GBD071	SF	Imported	yes	yes		2
GBD055	SF	Imported	yes	yes		2
GBD051	SF	Imported	yes	yes		2
GBD019	SF	Imported	yes	yes		2
GBD050	SB	Local	yes	yes		2
GBD052	RB	Local	yes		yes	2
GBD068	SB	Local	yes	yes		2
GBD075	PO	Local	yes		yes	2
GBD078	RB	Local	yes	yes		2
GBD081	RB	Local	yes	yes		2
GBD084	RB	Local	yes	yes		2
GBD106	PO	Local	yes		yes	2
GBD107	SB	Local	yes		yes	2
GBD108	PO	Local	yes		yes	2
GBD116	SB	Local	yes		yes	2
GBD138	PO	Local	yes		yes	2
GBD153	SB	Local	yes		yes	2
GBD154	SB	Local	yes		yes	2
GBD001	SB	Local	yes			1

GBD009	RB	Local	yes		1
GBD018	SB	Local	yes		1
GBD028	SB	Local	yes		1
GBD029	PO	Local	yes		1
GBD032	SPO	Local	yes		1
GBD035	SB	Local	yes		1
GBD044	SB	Local	yes		1
GBD045	SB	Local	yes		1
GBD053	SB	Local	yes		1
GBD056	RB	Local	yes		1
GBD060	SB	Local	yes		1
GBD063	RB	Local	yes		1
GBD065	SB	Local		yes	1
GBD066	PO	Local	yes		1
GBD073	PO	Local	yes		1
GBD074	SB	Local	yes		1
GBD076	SB	Local	yes		1
GBD165	SF	Imported	yes		1
GBD146	CO	Imported		yes	1
GBD130	SF	Imported		yes	1
GBD090	SF	Imported		yes	1
GBD067	SF	Imported	yes		1
GBD015	SF	Imported		yes	1
GBD007	SB	Imported	yes		1
GBD083	SF	Local		yes	1
GBD088	SB	Local	yes		1
GBD098	PO	Local	yes		1
GBD099	SB	Local	yes		1
GBD100	PO	Local	yes		1
GBD101	SB	Local	yes		1
GBD109	SB	Local	yes		1
GBD117	SB	Local	yes		1
GBD118	VO	Local		yes	1
GBD119	VO	Local		yes	1
GBD124	PO	Local	yes		1
GBD133	RB	Local	yes		1
GBD134	SB	Local	yes		1
GBD142	PO	Local	yes		1
GBD145	SB	Local	yes		1
GBD147	SB	Local	yes		1
GBD149	PO	Local	yes		1
GBD150	PO	Local	yes		1
GBD157	SB	Local	yes		1
GBD161	SB	Local	yes		1
GBD163	SB	Local	yes		1
GBD176	SB	Local	yes		1
GBD191	SB	Local	yes		1

Total number of oil brands 97

89

42

39

Annex 9 - Brand average price per liter

Average price per liter (BDT)				
Brand code	Oil type	Mean	Maximum	Minimum
GBD001	SB	105	105	105
GBD002	SB	105	108	100
GBD007	SB	100	100	100
GBD008	RB	134	145	102
GBD009	RB	127	127	127
GBD010	RB	130	133	125
GBD015	SF	275	275	275
GBD018	SB	105	105	105
GBD019	SF	315	355	274
GBD023	RB	140	250	90
GBD026	PO	91	105	70
GBD028	SB	91	92	90
GBD029	PO	90	90	90
GBD030	SB	106	108	94
GBD032	SPO	90	90	90
GBD033	SB	99	108	90
GBD035	SB	104	104	104
GBD044	SB	105	105	105
GBD045	SB	90	90	90
GBD046	PO	113	135	90
GBD048	SB	105	115	96
GBD050	SB	97	100	94
GBD051	SF	216	240	80
GBD052	RB	133	150	124
GBD053	SB	105	105	105
GBD055	SF	264	299	125
GBD056	RB	119	125	110
GBD057	RB	115	120	104
GBD060	SB	100	100	100
GBD061	RB	115	120	102
GBD063	RB	107	107	107
GBD065	SB	98	98	98
GBD066	PO	95	95	95
GBD067	SF	250	250	250
GBD068	SB	98	98	98
GBD069	RB	118	128	104
GBD071	SF	253	265	246
GBD073	PO	87	96	80
GBD074	SB	90	90	90
GBD075	PO	86	125	72
GBD076	SB			
GBD078	RB	128	130	120
GBD081	RB	120	125	101
GBD083	SF	355	355	355
GBD084	RB	200	225	150
GBD087	RB	116	134	100
GBD088	SB	100	100	100
GBD089	SF	267	275	235
GBD090	SF	278	280	270

GBD096	SB	105	186	54
GBD098	PO			
GBD099	SB	110	110	110
GBD100	PO	85	85	85
GBD101	SB	85	85	85
GBD102	SB	105	110	100
GBD104	PO	93	120	90
GBD106	PO	89	92	80
GBD107	SB	104	108	100
GBD108	PO	92	100	88
GBD109	SB			
GBD116	SB	105	106	100
GBD117	SB	108	110	105
GBD118	VO	90	90	90
GBD119	VO	90	90	90
GBD120	SF	268	275	250
GBD123	SF	246	248	240
GBD124	PO	95	95	95
GBD130	SF	245	245	245
GBD131	SF	230	240	220
GBD132	RB	121	128	102
GBD133	RB	130	130	130
GBD134	SB	130	130	130
GBD138	PO	72	90	37
GBD139	SF	255	275	207
GBD141	RB	124	220	100
GBD142	PO	82	82	82
GBD145	SB	100	100	100
GBD146	CO	450	450	450
GBD147	SB	108	108	108
GBD149	PO			
GBD150	PO	91	100	86
GBD153	SB	99	105	88
GBD154	SB	103	106	93
GBD157	SB	105	105	105
GBD161	SB	105	105	105
GBD163	SB	105	105	105
GBD165	SF	435	435	435
GBD168	PO	90	104	70
GBD172	RB	129	133	115
GBD174	SB	106	133	95
GBD176	SB	103	105	100
GBD178	RB	114	125	100
GBD189	VO	180	250	110
GBD191	SB	275	450	100
GBD193	SF	265	275	200
GBD196	SF	270	280	200
GBD197	SF	240	240	240
Total number of oil brands		97		

Annex 10 - List of brands available in CC, MC and UC

Brand code	Oil Type	CC	MC	UC
GBD002	SB	yes	yes	yes
GBD007	SB	yes		
GBD008	RB	yes	yes	yes
GBD009	RB	yes		
GBD010	RB	yes	yes	
GBD015	SF	yes		
GBD018	SB	yes		
GBD019	SF	yes		
GBD023	RB	yes	yes	yes
GBD026	PO	yes	yes	yes
GBD030	SB	yes	yes	yes
GBD032	SPO	yes		
GBD033	SB	yes	yes	yes
GBD046	PO	yes	yes	
GBD048	SB	yes	yes	yes
GBD050	SB	yes		yes
GBD051	SF	yes	yes	
GBD052	RB	yes	yes	
GBD053	SB	yes		
GBD055	SF	yes	yes	
GBD056	RB	yes		
GBD057	RB	yes		yes
GBD060	SB	yes		
GBD061	RB	yes		
GBD063	RB	yes	yes	
GBD065	SB	yes		
GBD067	SF	yes		
GBD068	SB	yes	yes	
GBD069	RB	yes		
GBD071	SF	yes	yes	yes
GBD073	PO	yes	yes	yes
GBD074	SB	yes		
GBD075	PO	yes	yes	yes
GBD078	RB	yes	yes	yes
GBD081	RB	yes	yes	
GBD083	SF	yes		
GBD084	RB	yes	yes	
GBD087	RB	yes	yes	
GBD089	SF	yes	yes	
GBD090	SF	yes	yes	
GBD096	SB	yes	yes	yes
GBD098	PO	yes	yes	yes
GBD102	SB	yes	yes	yes
GBD104	PO	yes	yes	
GBD106	PO	yes	yes	yes
GBD107	SB	yes	yes	yes
GBD108	PO	yes	yes	
GBD109	SB	yes		
GBD116	SB	yes	yes	yes
GBD118	VO	yes		
GBD119	VO	yes		
GBD120	SF	yes	yes	

GBD123	SF	yes	yes	
GBD130	SF	yes		
GBD131	SF	yes		
GBD134	SB	yes		
GBD138	PO	yes		yes
GBD139	SF	yes	yes	
GBD141	RB	yes	yes	yes
GBD142	PO	yes		
GBD146	CO	yes		
GBD153	SB	yes		
GBD154	SB	yes	yes	yes
GBD161	SB	yes		
GBD165	SF	yes		
GBD168	PO	yes	yes	yes
GBD172	RB	yes	yes	yes
GBD174	SB	yes	yes	yes
GBD176	SB	yes	yes	yes
GBD178	RB	yes	yes	
GBD189	VO	yes		
GBD191	SB	yes		
GBD193	SF	yes	yes	
GBD196	SF	yes	yes	
GBD197	SF	yes		
GBD001	SB		yes	
GBD028	SB		yes	yes
GBD029	PO			yes
GBD035	SB			yes
GBD044	SB			yes
GBD045	SB		yes	
GBD066	PO		yes	
GBD076	SB			yes
GBD088	SB		yes	
GBD099	SB		yes	
GBD100	PO			yes
GBD101	SB			yes
GBD117	SB			yes
GBD124	PO		yes	
GBD132	RB		yes	yes
GBD133	RB		yes	
GBD145	SB		yes	
GBD147	SB		yes	
GBD149	PO			yes
GBD150	PO		yes	
GBD157	SB		yes	
GBD163	SB		yes	
Total number of oil brands	97	75	57	36

Annex 11 - QC results and correction factor

Control	Date	Vitamin A [mg/kg]	Spiked sample mean (true content) [mg/kg]	Correction factor [mg/kg]	Correction factor mean of control	Correction factor
Control 1	Jun-17	1.97	5.1	2.59	2.72	2.86
Control 1	Jun-17	1.81	5.1	2.82		
Control 1	Jun-17	1.96	5.1	2.61		
Control 1	Jun-17	1.86	5.1	2.74		
Control 1	Jun-17	1.79	5.1	2.85		
Control 1	Jun-17	1.90	5.1	2.68		
Control 2	Jun-17	3.35	9.9	2.96	3.00	
Control 2	Jun-17	3.16	9.9	3.14		
Control 2	Jun-17	3.25	9.9	3.048		
Control 2	Jun-17	3.33	9.9	2.97		
Control 2	Jun-17	3.50	9.9	2.8		
Control 2	Jun-17	3.21	9.9	3.08		

Annex 12 - Number of retail outlet types where edible oil brands are available per division

Number of retail outlet types where brand is available by division										
Brand Code	Oil type	Origin	Barisal	Chittagong	Dhaka	Khulna	Mymensingh	Rajshahi	Rangpur	Sylhet
GBD001	SB	Local							1	
GBD002	SB	Local	2	2	3	2	2	2		1
GBD007	SB	Imported			1					
GBD008	RB	Local	2	3	3	2	2	2	1	1
GBD009	RB	Local		1						
GBD010	RB	Local	1	2			2	1	1	
GBD015	SF	Imported			1					
GBD018	SB	Local	1							
GBD019	SF	Imported			2					
GBD023	RB	Imported	2	3	3	3	2	2	1	2
GBD026	PO	Local	3	3	3	3	1	2	1	3
GBD028	SB	Local					1			
GBD029	PO	Local	1							
GBD030	SB	Local	3	3	3	3	2	3	2	3
GBD032	SPO	Local			1					
GBD033	SB	Local	2	1		1		2		2
GBD035	SB	Local	1							
GBD044	SB	Local						1		
GBD045	SB	Local			1					
GBD046	PO	Local		1						1
GBD048	SB	Local	3	3	3	3	2	3	2	3
GBD050	SB	Local				2				
GBD051	SF	Imported		1	2			1		2
GBD052	RB	Local		1	2					
GBD053	SB	Local		1						
GBD055	SF	Imported/ Local		2	2			1		
GBD056	RB	Local							1	
GBD057	RB	Local	2		1					
GBD060	SB	Local		1						
GBD061	RB	Local		2	1			2		
GBD063	RB	Local		1						1
GBD065	SB	Local		1						
GBD066	PO	Local								1
GBD067	SF	Imported		1	1					
GBD068	SB	Local			2					
GBD069	RB	Local		1	2					
GBD071	SF	Imported		2	2	1		1		1
GBD073	PO	Local								1
GBD074	SB	Local								1
GBD075	PO	Local								2
GBD076	SB	Local								1
GBD078	RB	Local				2	2	1	2	
GBD081	RB	Local		1	2					
GBD083	SF	Local			1					
GBD084	RB	Local		1	2		1	1		1
GBD087	RB	Local		1			2			
GBD088	SB	Local					1			
GBD089	SF	Imported		1	2			1		1
GBD090	SF	Imported		1				1		1

GBD096	SB	Local	3	3	2	3	2	3	1	3
GBD098	PO	Local							1	
GBD099	SB	Local			1					
GBD100	PO	Local						1		
GBD101	SB	Local						1		
GBD102	SB	Local			1	3	1	1	1	2
GBD104	PO	Local			2	3				1
GBD106	PO	Local	1			2				2
GBD107	SB	Local		2				1	1	
GBD108	PO	Local								2
GBD109	SB	Local								1
GBD116	SB	Local		2		2		2	1	
GBD117	SB	Local								1
GBD118	VO	Local								1
GBD119	VO	Local								1
GBD120	SF	Imported		2	2					1
GBD123	SF	Imported		2	2		1	2		
GBD124	PO	Local								1
GBD130	SF	Imported			1					
GBD131	SF	Imported			1			1		
GBD132	RB	Local		2	1			2		
GBD133	RB	Local							1	
GBD134	SB	Local		1						
GBD138	PO	Local								2
GBD139	SF	Imported			2			1		
GBD141	RB	Local	2	3	2	3	2	2	1	1
GBD142	PO	Local								1
GBD145	SB	Local								1
GBD146	CO	Imported		1						
GBD147	SB	Local								1
GBD149	PO	Local								1
GBD150	PO	Local								1
GBD153	SB	Local		2				1		
GBD154	SB	Local	1	1				1	1	1
GBD157	SB	Local	1							
GBD161	SB	Local	1							
GBD163	SB	Local			1					
GBD165	SF	Imported			1					
GBD168	PO	Local	2	1	2	3	1			2
GBD172	RB	Local	1	2	1	3		2		2
GBD174	SB	Local	3	3	3	3	2	3	2	3
GBD176	SB	Local		1	1			1		1
GBD178	RB	Local			1		2	3	1	
GBD189	VO	Imported		2						
GBD191	SB	Local			1					
GBD193	SF	Imported	2	3	3		2	2		3
GBD196	SF	Imported		2	1		1	1		
GBD197	SF	Imported			2					
Total number of oil brands	97	Number of brands available in each division	22	44	46	19	21	36	19	43

Annex 13 - Brand composite and single samples analyzed per division

Brand Code	Fortification status	Brand Code	Mean vit A content (mg/kg)	No of Composite samples analyzed								Composite Sample Code	No of single samples in each composite
				Barisal	Chittagong	Dhaka	Khulna	Mymensingh	Rajshahi	Rangpur	Sylhet		
GBD002	Fortified below standard	SB	9.11	1			1	1	1			BAD-B8-133 KHD-B24-130 MYD-B11-109 RJD-B18-059	12 12 12 12
GBD007	Not fortified	SB	0.00			1						DHD-B12-162	5
GBD008	Fortified above minimum range	RB	20.11	1	1	1	1		1	1	1	BAD-B21-137 CHD-B12-063 DHD-B17-100 KHD-B17-128 RAD-B13-054 RJD-B13-056 SYD-B34-071	12 12 12 12 12 12 12
GBD009	Not fortified	RB	0.00		1							CHD-B18-163	5
GBD010	Fortified above minimum range	RB	14.16	1	1			1	1	1		BAD-B20-080 CHD-B30-113 MYD-B12-110 RAD-B15-117 RJD-B27-121	12 12 12 12 12
GBD018	Fortified below standard	SB	3.50	1								BAD-B24-081	12
GBD023	Fortified above minimum range	RB	34.76	1	1	1	1		1	1		BAD-B25-083 CHD-B14-065 DHD-B15-098 KHD-B14-125 RAD-B19-118 RJD-B16-057	12 12 12 12 12 12
GBD026	Fortified above minimum range	PO	22.22	1	1	1	1	1	1	1	1	BAD-B4-131 CHD-B2-043 DHD-B16-099 KHD-B4-087 MYD-B3-047 RAD-B10-053 RJD-B6-055 SYD-B1-015	12 12 12 12 12 12 12 12
GBD030	Fortified above minimum range	SB	24.26	1	1	1	1	1	1	1	1	BAD-B1-072 CHD-B5-046 DHD-B3-002 KHD-B9-089 MYD-B2-028 RAD-B1-007 RJD-B8-037 SYD-B2-016	12 12 12 12 12 12 12 12
GBD033	Fortified above minimum range	SB	18.00	1			1		1		1	BAD-B17-079 KHD-B19-152 RJD-B19-032 SYD-B10-145	12 4 12 10
GBD035	Not fortified	SB	0.00	1								BAD-B14-188	1
GBD044	Fortified below standard	SB	7.68						1			RJD-B10-187	1
GBD045	Fortified above minimum range	SB	14.65					1				MYD-B5-048	12

GBD046	Fortified above minimum range	PO	28.65								1	SYD-B23-153	1
GBD048	Fortified below standard	SB	7.03	1	1	1	1	1	1	1	1	BAD-B9-076 CHD-B7-004 DHD-B7-003 KHD-B2-085 MYD-B1-027 RAD-B2-008 RJD-B9-038 SYD-B11-068	12 12 12 12 12 12 12 12
GBD050	Not fortified	SB	0.00				1					KHD-B11-090	12
GBD053	Not fortified	SB	0.00		1							CHD-B28-167	1
GBD055	Fortified above minimum range	SF	15.32			1						DHD-B14-151	2
GBD056	Fortified above minimum range	RB	15.66							1		RAD-B16-155	4
GBD057	Fortified above minimum range	RB	25.92	1								BAD-B18-182	1
GBD060	Not fortified	SB	0.00		1							CHD-B29-168	1
GBD061	Fortified above minimum range	RB	17.83						1			RJD-B28-157	2
GBD065	Not fortified	SB	0.00		1						1	CHD-B23-165	2
GBD066	Not fortified	PO	0.00									SYD-B28-180	2
GBD068	Not fortified	SB	0.00			1						DHD-B27-108	12
GBD073	Not fortified	PO	0.00								1	SYD-B24-177	4
GBD074	Not fortified	SB	0.00								1	SYD-B36-185	2
GBD075	Not fortified	PO	0.00								1	SYD-B8-170	6
GBD076	Not fortified	SB	0.00								1	SYD-B7-169	2
GBD078	Fortified above minimum range	RB	21.09				1					KHD-B12-154	7
GBD081	Fortified above minimum range	RB	18.91		1	1						CHD-B17-140 DHD-B13-097	11 12
GBD084	Fortified above minimum range	RB	30.71								1	SYD-B32-183	1
GBD087	Fortified slightly below standard	RB	12.06					2				MYD-B13-191 MYD-B14-186	5 3
GBD096	Fortified above minimum range	SB	31.89	1	1	1	1	1	1	1	1	BAD-B10-077 CHD-B4-045 DHD-B1-1 KHD-B3-086 MYD-B8-050 RAD-B8-012 RJD-B4-024 SYD-B3-017	12 12 12 12 12 12 12 12
GBD098	Not fortified	PO	0.00							1		RAD-B7-011	12
GBD099	Not fortified	SB	0.00			1						DHD-B6-161	1
GBD102	Fortified above minimum range	SB	32.65			1	1		1		1	DHD-B4-148 KHD-B18-091 RJD-B11-023 SYD-B21-143	3 12 12 9
GBD104	Fortified above	PO	29.42				1				1	KHD-B15-159 SYD-B17-022	8 12

	minimum range											KHD-B8-088	12
												MYD-B7-049	12
												RAD-B11-014	12
												RJD-B5-025	12
												SYD-B13-021	12
GBD176	Fortified above minimum range	SB	25.94							1		SYD-B35-184	3
GBD178	Fortified below standard	RB	7.12					1				MYD-B6-146	1
GBD193	Fortified slightly below standard	SF	11.95		1		1					CHD-B13-064	12
												KHD-B21-142	3
	Total number of composite samples by division			20	19	17	19	12	20	12	32		
	Total number of oil brands analyzed			66									

7 Glossary

Availability: Term used to define brands that were found in markets. Used interchangeably with presence.

Market hub: agglomeration (city, town, village) located on the nodes of the main supply routes of oil with higher population density and where larger volumes of food products are sold or passed through and dispatched to other places.

Market place: a place where a high number of vendors or retail outlets are concentrated and where buyers and sellers of vegetable oil are able to interact.

Open packaging labeled: packaging that is not sold as such and is opened before it is sold to the end user but labeled with producer name or open packaging with label.

Open packaging unlabeled: Packaging that is not sold as such and is opened before it is sold to the end user but and without label.

Presence: Term used to define brands that were found in markets. Used interchangeably with availability.

Retail shop: a small sale outlet offering variety of goods to a local community of area, like convenience store. Stores can be either located in a street or are concentrated in a bazar.

Retail outlet: Vendors or businesses that sell edible oil (wholesalers, retail shops, super markets, exporters etc.).

Sealed packaging branded & labeled: Sealed containers labeled with brand name and producer information.

Supermarket/superstore: a very large store that sells a wide variety of goods placed in specific departments.

Wholesaler/trader/importers: an intermediary entity in the distribution channel that buys in bulk and sells to resellers rather than to consumers. In its simplest form, a distributor performs a similar role but often provides more complex services.

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